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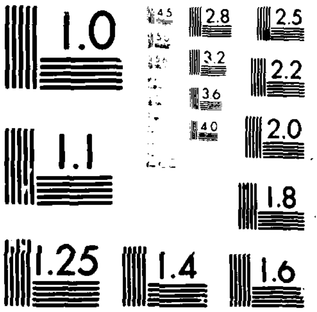

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USER'S MANUAL FOR COMPUTER PROGRAMS TO PERFORM OCEANOGRAPHIC VECTOR TIME SERIES DATA ANALYSIS AND RELATED GRAPHICS

Submitted to:

The Naval Ocean Research and Development Activitiy,
Ocean Environmental Measurements Program
(Code 500)

In partial fulfillment of requirements under
Contract N00014-78-C-0879

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(11) January, 1980

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Preface

This "User's Manual for Computer Programs to Perform Oceanographic Vector Time Series Analysis" was prepared for the Environmental Measurements Program (Code 500) of NORDA in partial fulfillment of requirements under an Office of Naval Research Contract number N00014-78-C-0879. The software is written in Fortran IV specifically for use on the UNIVAC 1108 computer located at NAVOCEANO in NSTL Station, Mississippi. It is capable of accommodating any vector time series data, but the products are specifically directed at meteorologic and physical oceanographic data including current meter and wind data. The guidelines on this effort were that the vector time series software had to be compatible with existing FESTSA software at NAVOCEANO and that the plotting routines were to utilize the sophisticated DISSPLA software currently available at NAVOCEANO; both of these were adhered to. Both the rotary spectral and rotary cross spectral programs are designed to read directly from the FEB files of the FESTSA system. Another critical requirement was to extend the capability of the user to process records of lengths other than 2^n; this was accomplished by incorporating the mixed radix fast Fourier transform program of Singleton (1969) which is based on prime factors. This feature enables users to select records of length 2^n, if desired, but it is not a limitation as in many other vector time series analysis programs. Subroutines are available for pre-whitening and post-coloring of data, if desired, and there are a number of data "windows" available along with three different types of averaging: block, convolution, and a combination of the two. In all there are a number of valuable user options included in the data analysis and graphics software which make it quite flexible and powerful.

The user's manual is organized into three parts: an introduction including a brief explanation of the theory behind vector time series analysis; a description of all the data analysis and graphics programs; and a series of five appendices with program and data set listings. Two cautions must be emphasized in using this manual:

(1) This is not intended to be, nor is it a complete treatise on the subject of time series data analysis. It is recommended that some preliminary reading be done in one or more of the references cited herein.

(2) Read this manual very carefully before attempting to use the software programs. The very nature of the analysis dictates careful reading, and in order to fully realize the benefits of available user options one must understand how they are called.

Acknowledgements

JAYCOR would like to extend its thanks to Dr. Mike Stanley for all his assistance in this effort. Special thanks are extended to Dr. Kim Saunders for his invaluable aid in working with the UNIVAC system and Mr. Mark Bergin for his perseverance during the testing phase of the draft user's manual.

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1.0 INTRODUCTION

1.0 INTRODUCTION

The application of spectral analysis to oceanographic time series has become routine over the past decade. The purposes have generally been to assess the time scales and the distribution of variance (energy) between differing geophysical processes, to determine the spatial structure of these processes, and to determine interrelationships between processes.

Spectral analysis tools primarily evolved through the field of communications engineering, e.g., Blackman and Tukey (1958) where initial oceanographic applications were for the analysis of scalar time series. Some examples regarding sea level fluctuations include Groves and Hannan (1968) and Wunsch (1972). The increased availablility and complexity of oceanographic velocity time series in the mid-1960's led to new problems. Applications of scalar techniques to velocity vector components generally yielded results that depended upon coordinated system orientation. This necessitated the development of invariant statistics and rotary spectral analysis. Pioneering work includes the papers by Fofonoff (1969), Gonella (1972), and Mooers (1973). Applications to internal inertia-gravity waves includes Muller and Siedler (1976) and Muller, Olbers and Willebrand (1978). Recent applications to atmospheric and oceanic planetary wave analyses respectively includes Hayashi (1979) and Weisberg, Horigan, and Colin (1979).

Four separate programs are utilized to generate spectral quantities for plotting and analysis: GET, FOURCO, RSPEC, and RCSPEC. GET removes the desired time series from a Febfile and outputs it to a new dataset for use by FOURCO. FOURCO then computes the time series mean, variance, and Fourier coefficients. A variety of spectral windows and prewhitening are available as options. The Fourier coefficients are then fed into RSPEC and RCSPEC to perform rotary spectral analysis for a single vector time series and rotary cross spectral analysis for a pair of vector time series respectively. Both spectral programs output datasets for plotting purposes. Printouts may also be obtained. The programs are set up so that one runstream can be used with finished, plotted results as an end product.

This user's manual consists of several parts. Section 2 develops the velocity hodograph model and discusses the various computations. The data analysis programs and all options are presented in Section 3. Section 4 describes the plotting routines. Finally, the source listings are given as appendices.

2.0 COMPUTATIONS

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2.1 The Velocity Hodograph

Consider a time series consisting of a single Fourier constituent at a given frequency f. The trigonometric representation of the east and north velocity components (u, v) in a cartesian coordinate system (x, y) are:

$$u = a_1 \cos 2\pi ft + b_1 \sin 2\pi ft$$
$$v = a_2 \cos 2\pi ft + b_2 \sin 2\pi ft,$$

where the a's and b's are the Fourier coefficients. Owing to the orthogonality of the trigonometric functions any piecewise continuous time series can be viewed as a linear superposition of Fourier constituents at different frequencies. The Fourier coefficients are then obtained via finite Fourier transformation.

In complex form, u and v may be rewritten as:

$$u = 1/2 \left[(a_1 - ib_1)\, e^{i2\pi ft} + (a_1 + ib_1)\, e^{-i2\pi ft}\right]$$
$$v = 1/2 \left[(a_2 - ib_2)\, e^{i2\pi ft} + (a_2 + ib_2)\, e^{-i2\pi ft}\right]$$

where $i = (-1)^{1/2}$. Defining now, the complex velocity vector in the argand plane,

$$w = u + iv,$$

and upon substitution and rearrangement:

$$w = \left[\frac{a_1+b_2}{2}\right] e^{i2\pi ft} + i\left[\frac{a_2-b_1}{2}\right] e^{i2\pi ft} + \left[\frac{a_1-b_2}{2}\right] e^{-i2\pi ft} + i\left[\frac{a_2+b_1}{2}\right] e^{-i2\pi ft}$$

Further definition of the quantities:

$$A = 1/2 \left[(a_1+b_2)^2 + (a_2-b_1)^2\right]^{1/2}$$

$$C = 1/2 \left[(a_1-b_2)^2 + (a_2+b_1)^2\right]^{1/2}$$

$$\eta = \tan^{-1} \left(\frac{a_2-b_1}{a_1+b_2}\right)$$

$$-\tau = \tan^{-1} \left(\frac{a_2+b_1}{a_1-b_2}\right)$$

allows w to be expressed as:

$$w = Ae^{i\eta}\, e^{i2\pi ft} + Ce^{-i\tau}\, e^{-i2\pi ft}$$

In this form, the quantities defined have a simple conceptual basis. The + and - exponentials correspond to anticlockwise and clockwise rotating unit vectors respectively in the argand plane. Therefore, A and C are the amplitudes of the anticlockwise and clockwise components, *and and are their corresponding temporal phase angles.*

As the vector w sweeps through a cycle in the argand plane, its tip traces out a hodograph which has a simple geometrical interpretation. Factoring out $e^{i(\eta-\tau)/2}$, w may be rewritten as:

$$w = e^{i(\eta-\tau)/2} \left[Ae^{i\{2\pi ft + 1/2(\eta+\tau)\}} + Ce^{-i\{2\pi ft + 1/2(\eta+\tau)\}}\right]$$

$$= e^{i(\eta-\tau)/2}\, w' \quad .$$

Hence w is expressed as a second vector function w′ rotated anticlockwise through an angle $(\eta-\tau)/2$. In trigonometric form:

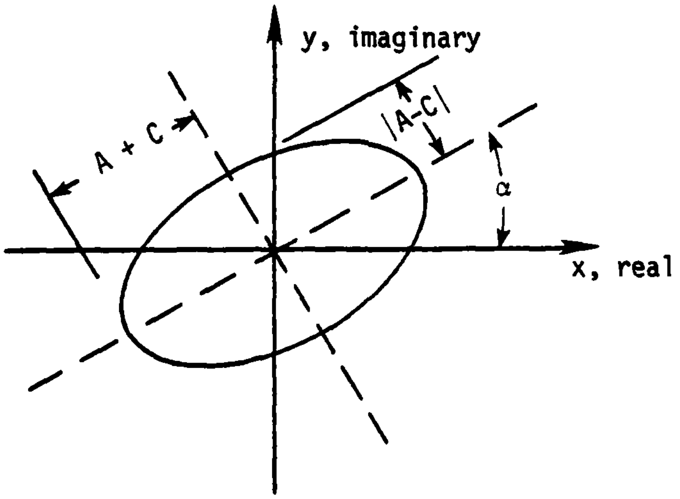
$$w' = (A+C)\cos\left\{2\pi ft + 1/2(\eta+\tau)\right\} + i(A-C)\sin\left\{2\pi ft + 1/2(\eta+\tau)\right\}$$

$$= w_R' + i\, w_I'$$

Dividing w_R' by A+C and w_I' by A-C, squaring, and adding, yields an equation for an ellipse in the argand plane:

$$\frac{w_R'^{\,2}}{(A+C)^2} + \frac{w_I'^{\,2}}{(A-C)^2} = 1.$$

The semimajor axis of the ellipse is A+C, the semiminor axis is $|A-C|$, and the orientation of the principal axis of variance (semimajor axis) is $\alpha = (\eta - \tau)/2$. This is shown schematically below.



The ellipse is polarized anticlockwise if A>C, clockwise if A<C, and it is rectilinear if A=C. If either A or C equals zero, then the ellipse is a circle with the appropriate polarization.

The principal axis of variance defines a new coordinate system in which w_R' and w_I' are in quadrature. Consequently the average of their products equals zero ($\langle w_R' w_I' \rangle = 0$) and they are orthogonal. The new coordinate system therefore corresponds to the normal coordinates of the time series at frequency f. The temporal phase angle of the velocity vector relative to the normal coordinates is given by:

$$\theta = \tan^{-1} \frac{w_I'(0)}{w_R'(0)} = \tan^{-1} \left[\frac{A-C}{A+C} \tan 1/2 \, (\eta+\tau) \right]$$

2.2 Rotary Spectra

Rotary spectra and hodograph parameters for single vector time series and pairs of vector time series are computed by RSPEC and RCSPEC respectively. The computed quantities are formulated in this section. The next section then discusses scaling, averaging, and other computational aspects.

Following Muller and Sieldler (1976), the anticlockwise and clockwise horizontal velocity component transforms (U_+ and U_- respectively) are defined for positive frequency as

$$U_+ = U + iV$$

$$U_- = U - iV$$

where U, V are proportional to the complex Fourier coefficients at a given frequency f computed via finite Fourier transformation. Since f is chosen as positive (as opposed to positive or negative in the previous section) we consider Fourier coefficients of the form a - ib as opposed to a + ib. Rotary cross-spectra between two vector time series at locations A and B are given by

$$S_{\nu\mu}^{AB} = U_\nu^{A*} \, U_\mu^B$$

where ν and μ are either plus or minus and the asterisk denotes the complex conjugate. Thus:

$$S_{++}^{AB} = U_{+}^{A*}\ U_{+}^{B}$$

$$S_{--}^{AB} = U_{-}^{A*}\ U_{-}^{B}$$

$$S_{+-}^{AB} = U_{+}^{A*}\ U_{-}^{B}$$

$$S_{-+}^{AB} = U_{-}^{A*}\ U_{+}^{B}$$

In general, the rotary-cross spectra are complex valued functions with an amplitude and phase. They satisfy the relationship,

$$S_{\nu\mu}^{AB} = (S_{\mu\nu}^{BA})^{*};$$

therefore the above four cross-spectra are sufficient to describe all of the linear relationships between the vector time series at points A and B. Normalizing the amplitude of the rotary cross-spectra between points A and B by the respective rotary spectra at these points results in the rotary coherencies. Thus:

$$\gamma_{\nu\mu}^{AB^2} = \frac{S_{\nu\mu}^{AB}\ \left[S_{\nu\mu}^{AB}\right]^{*}}{S_{\nu\nu}^{AA}\ \ S_{\mu\mu}^{BB}}$$

where $\gamma_{\nu\mu}^{AB^2}$, the rotary coherence squared, is a real valued function ranging between zero and unity. The phase difference between rotary components at location A and B follow from the real and imaginary parts of the rotary cross spectra or,

$$\phi_{\nu\mu}^{AB} = \tan^{-1}\left[\frac{\text{Im}\ \{S_{\nu\mu}^{AB}\}}{\text{Re}\ \{S_{\nu\mu}^{AB}\}}\right] ,$$

where the imaginary part (Im) is called the rotary quadrature spectrum and the real part (Re) is called the rotary co-spectrum. The sign convention employed is

$$S^{AB}_{\nu\mu} = \mathrm{Re}\left\{S^{AB}_{\nu\mu}\right\} + i\ \mathrm{Im}\left\{S^{AB}_{\nu\mu}\right\} = \left|S^{AB}_{\nu\mu}\right|\ e^{i\phi^{AB}_{\nu\mu}}\ ,$$

thus a positive phase implies that oscillations at B lead those at A and conversely.

The programs employ complex arithmetic therefore the equations given above are sufficient for the calculations. With some arithmetic, however, the rotary cross-spectra can be computed in terms of the conventional scalar velocity component spectra. This will now be shown for the case of a single vector time series for which A = B. Only 3 rotary cross-spectra need be computed since $S_{-+} = S_{+-}{}^*$. Thus

$$\begin{aligned} S_{++} = U_+^* U_+ &= (U^* - iV^*)\ (U + iV) \\ &= U^*U + V^*V + i\ (U^*V - V^*U) \\ &= Suu + Svv + i\ (Suv - Svu); \end{aligned}$$

but, $S_{vu} = S^*_{uv}$, so

$$\begin{aligned} S_{++} &= Suu + Svv + i\ (2\ i\ \mathrm{Im}\ \{Suv\}) \\ &= Suu + Svv - 2\ \mathrm{Im}\ \{Suv\}. \end{aligned}$$

Similarly:

$$S_{--} = Suu + Svv + 2\ \mathrm{Im}\ \{Suv\}$$

and

$$S_{-+} = Suu - Svv + i\ 2\ \mathrm{Re}\ \{Suv\}$$

where *Suu*, *Svv*, *and* Suv are the scalar autospectra for the u and v components and the cross-spectrum between u and v. S_{++} and S_{--} are the anticlockwise and clockwise rotary spectra while S_{-+} is the cross-spectrum between the clockwise and the anticlockwise components.

Expanding S_{++} and S_{--} further in terms of the Fourier coefficients yields:

$$S_{++} = 1/4\ (a_1+ib_1)\ (a_1-ib_1) + 1/4\ (a_2+ib_2)\ (a_2-ib_2) +$$

$$\frac{i}{4}\ \ (a_1+ib_1)\ (a_2-ib_2) - (a_2+ib_2)\ (a_1-ib_1)$$

$$= 1/4\ (a_1^2+b_1^2+a_2^2+b_2^2) +$$

$$\frac{i}{4}\left[a_1a_2+b_1b_2+i\ (a_2b_1-a_1b_2)\ -a_1a_2-b_1b_2-i\ (a_1b_2-a_2b_1)\right]$$

$$= 1/4\left[a_1^2+b_1^2+a_2^2+b_2^2 + 2a_1b_2 - 2a_2b_1\right]$$

$$= 1/4\left[(a_1+b_2)^2 + (a_2-b_1)^2\right]$$

$$= A^2$$

where A is the amplitude of the anticlockwise component computed in section II for the velocity hodograph model. Similarly $S_{--} = C^2$.

The coherence squared between the clockwise and anticlockwise components and their phase difference define the orientation of the velocity hodograph and the stability of the ellipse (Gonella, 1972). The coherence squared, or stability, is given by:

$$\gamma^2_{-+} = \frac{S_{-+}\,S^*_{-+}}{S_{++}\,S_{--}} = \gamma^2_{+-}$$

$$= \frac{(Suu-Svv)^2 + 4\ \mathrm{Re}^2\ \{Suv\}}{(Suu+Svv)^2 - 4\ \mathrm{Im}^2\ \{Suv\}}\ .$$

The phase difference is:

$$\phi_{-+} = \tan^{-1}\left[\frac{2\ \mathrm{Re}\ \{Suv\}}{Suu - Svv}\right]$$

and the orientation $\alpha = 1/2\,\phi_{-+}$ (note that α is $^{\pi}/4$ when $Suu = Svv$ whereas $\phi_{-+} = \frac{\pi}{2}$). Thus

$$\tan 2\alpha = \frac{2\ \mathrm{Re}\ \{Suv\}}{Suu - Svv}$$

or in terms of the Fourier coefficients

$$\tan 2\alpha = \frac{(2)(1/4)\ (a_1a_2+b_1b_2)}{1/4\ (a_1^2+b_1^2-a_2^2-b_2^2)}$$

$$\tan 2\alpha = \frac{2a_1a_2 + 2b_1b_2}{a_1^2+b_1^2 - a_2^2-b_2^2}$$

This agrees with the results obtained from the velocity hodograph model as will now be shown. Recalling that

$$2\alpha = \eta-\tau$$

and performing the trigonometry and arithmetic we see that:

$$\tan 2\alpha = \tan(\eta-\tau) = \frac{\tan\eta - \tan\tau}{1 + \tan\eta\ \tan\tau}$$

$$= \frac{2a_1a_2 + 2b_1b_2}{a_1^2+b_1^2 - a_2^2-b_2^2} ,$$

which is the same as that found above.

In our formulation, positive ϕ_{-+} means that the anticlockwise component leads the clockwise component. Positive η means that the anticlockwise unit vector is advanced anticlockwise (it lies above the real axis at $t = o$) while positive τ means that the clockwise unit vector is advanced clockwise (it lies below the real axis at $t = o$). If the anticlockwise component leads, i.e. it is advanced more than the clockwise is advanced, then the orientation, $(\eta-\tau)/2$, will be positive.

Thus, the rotary spectral respresentation

$u_+ = u + iv$

$u_- = u - iv$

for positive frequency with Fourier coefficients

$$\frac{a_1-ib_1}{2} \quad , \quad \frac{a_2-ib_2}{2}$$

yields identical results as the conceptually simpler but algebraically more difficult velocity hodograph model with ± frequencies.

Additional ellipse parameters calculated by RSPEC include the ellipse semimajor axis, the semiminor to semimajor axis ratio and two other coherencies: the minimum and maximum coherencies squared between the cartesian velocity component of a single vector time series. The semimajor axis, SMAJOR, is the r.m.s. fluctuation along the principal axis of variance and the axis ratio, RATIO, is the speed ratio in the normal coordinate system.

2.3 Basic Scaling

Several steps go into the calculation of averaged and scaled spectral estimates. They begin with the finite Fourier transform over the interval $o \leq t \leq T$:

$$X(f\ ,\ T) = \int_0^T x(t)e^{i2\pi ft}dt$$

In discrete form:

$$X(f,\ T) = \sum_{n=0}^{N-1} x(nh)e^{i2\pi ft}\ \ h$$

where h is the sampling interval which we call "step" in the programs. The discrete respresenation results in frequency domain sampling at the discrete frequencies $f = k/T = k/Nh$; $k = 0, 1, 2,$ --- $N-1$. Thus:

$$X(f,\ T) = h \sum_{n=0}^{N-1} x(n)\ e^{i2\ kn/N}\ ,\ k=0,\ 1,\ 2,\ ---,\ N-1.$$

The function $X(f\ ,\ T)$ is generally complex and is proportional to the Fourier coefficients of the time series.

One-sided power spectra derive from:

$$G_X(f) = \frac{2}{Nh}\left|X(f\ ,T)\right|^2\ ,$$

the factor of two arising from the two-sided nature of the function $X(f, T)$, i.e. it folds about the Nyquist frequency occurring at $k = {}^{N}/2$. The FFT subroutine actually outputs the quantity $X_k=X(f, T)/h$; therefore, the basic power spectral estimate is computed from:

$$G_{xx}(f) = \frac{2h}{N}\left|X_k\right|^2 .$$

Assuming that the input time series has units of cm/sec and the sampling interval has units of hours, the spectral density function $G_{xx}(f)$ will have units of $(cm/sec)^2/c.p.h.$ Note that rotary spectra have the same initial scaling with the exception of the factor of two since G_{++} and G_{--} are each one-sided spectra. Thus,

$$G_{++} + G_{--} = Guu + Gvv.$$

The basic power spectral estimate is scaled in accordance with three options: 1) augmenting the record length with zeros; 2) windowing; and 3) pre-whitening. Record length augmentation alters the frequency domain sampling to $f = {}^{k}/N'h$ from $f = {}^{k}/Nh$ where N and N$'$ are the original and augmented number of samples. Thus a factor of ^{N} /N is applied to scale the variance up to its nonaugmented value. Windowing also reduces variance by weighting the ends of the records less than the middle. Thus a factor of:

$$\left[\int_0^T W^2(t)dt\right]^{-1}$$

is applied to scale the variance back up to its nonwindowed amount. Note that this procedure is only valid if the window function is uncorrelated with the data. The existence of trends, nonstationary variance, or periodic components in phase with the particular window could cause the integral of the scaled spectral density to differ slightly from the original time series variance. This is generally the case and attempts at further rectification without an *a priori* knowledge of the cause would lead to an alteration of the spectral slope which is not desirable.

The basic scaling including the correction for record length augmentation is accomplished via the parameter called FACTOR which is the sampling interval (STEP) divided by the original number of samples (LENGTH). Further corrections for windowing and/or pre-whitening are chosen as options as discussed in the following two sections.

2.4 Windowing

The following six windows are available: 1) Boxcar or no-shading; 2) 10% cosine taper; 3) Hanning; 4) Hamming; 5) Lanczos; and 6) Parzen. Their shape and discrete formulations are given in the accompanying figures (1 through 5) with the exception of the boxcar which is unity. The 10% cosine taper is generally adequate.

2.5 Pre-whitening/Post-coloring

Pre-whitening/Post-coloring is a tool used for reducing the leakage from low to high frequency estimates e. g. see Blackman and Tukey (1956) for a discussion of finite record length effects. The pre-whitening filter available herein is a first difference high pass filter of the form:

$$y(t) = x(t + h) - x(t)$$

where x(t) is the original time series and y(t) is the pre-whitened time series. Its frequency response function may be easily calculated by considering its effect upon a component sinusoid. Let $x(t)=C_n e^{i\omega_n t}$

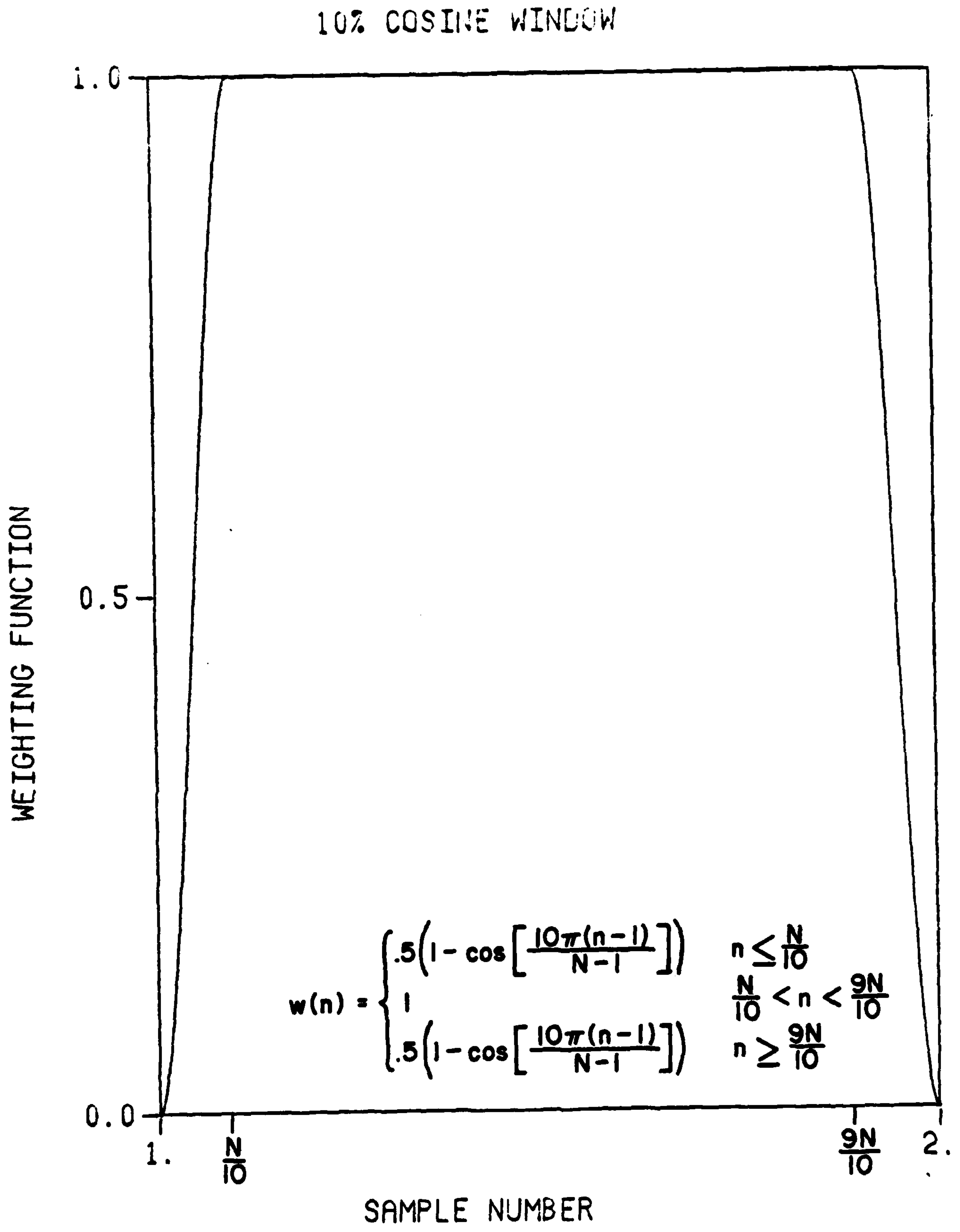

10% COSINE WINDOW
WEIGHTING FUNCTION
1.0
0.5
0.0
$w(n) = \begin{cases} .5\left(1-\cos\left[\frac{10\pi(n-1)}{N-1}\right]\right) & n \leq \frac{N}{10} \\ 1 & \frac{N}{10} < n < \frac{9N}{10} \\ .5\left(1-\cos\left[\frac{10\pi(n-1)}{N-1}\right]\right) & n \geq \frac{9N}{10} \end{cases}$
1.
$\frac{N}{10}$
$\frac{9N}{10}$
2.
SAMPLE NUMBER

Figure 1.

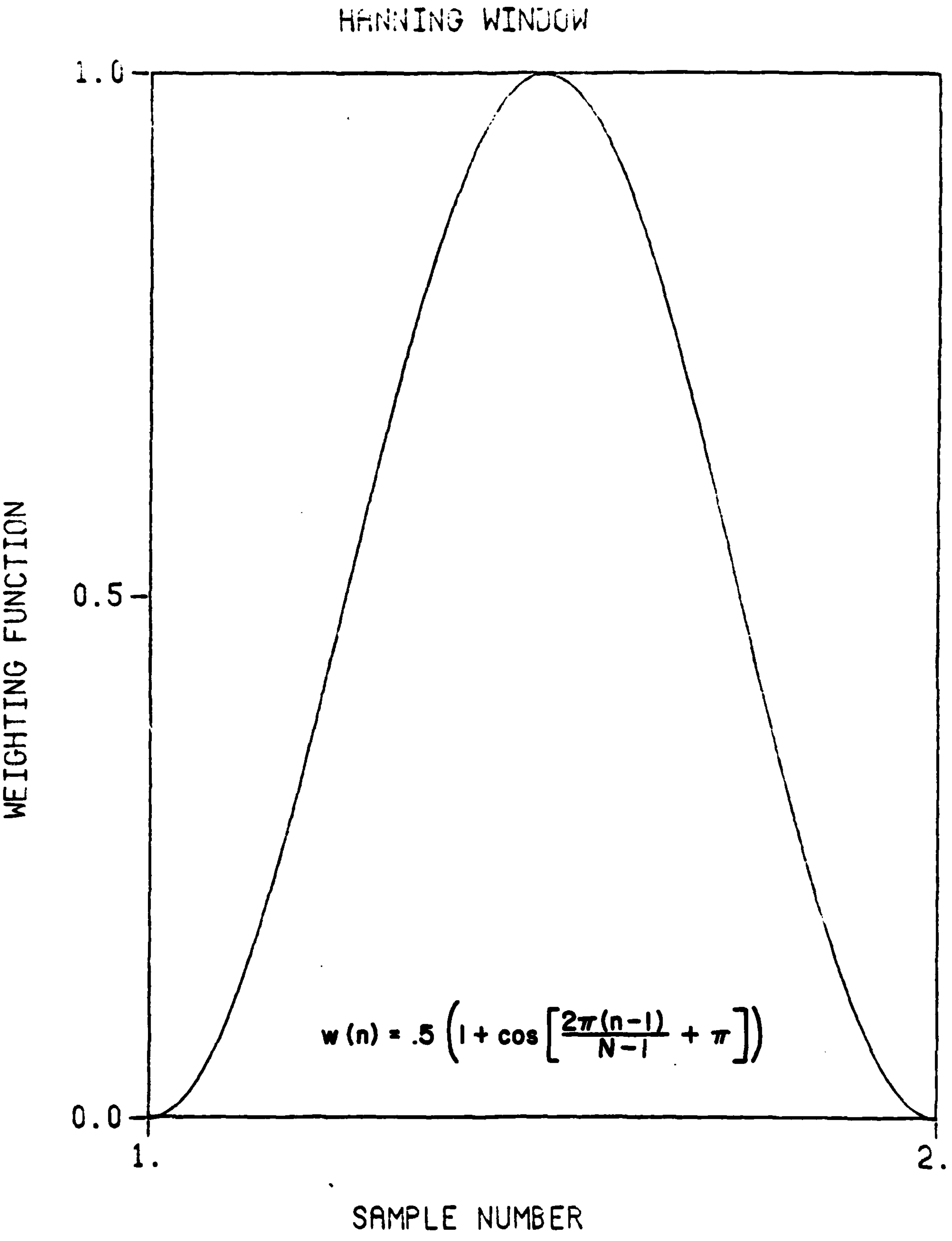

HANNING WINDOW
1.0
0.5
0.0
WEIGHTING FUNCTION
$w(n) = .5\left(1 + \cos\left[\frac{2\pi(n-1)}{N-1} + \pi\right]\right)$
1.
2.
SAMPLE NUMBER

Figure 2.

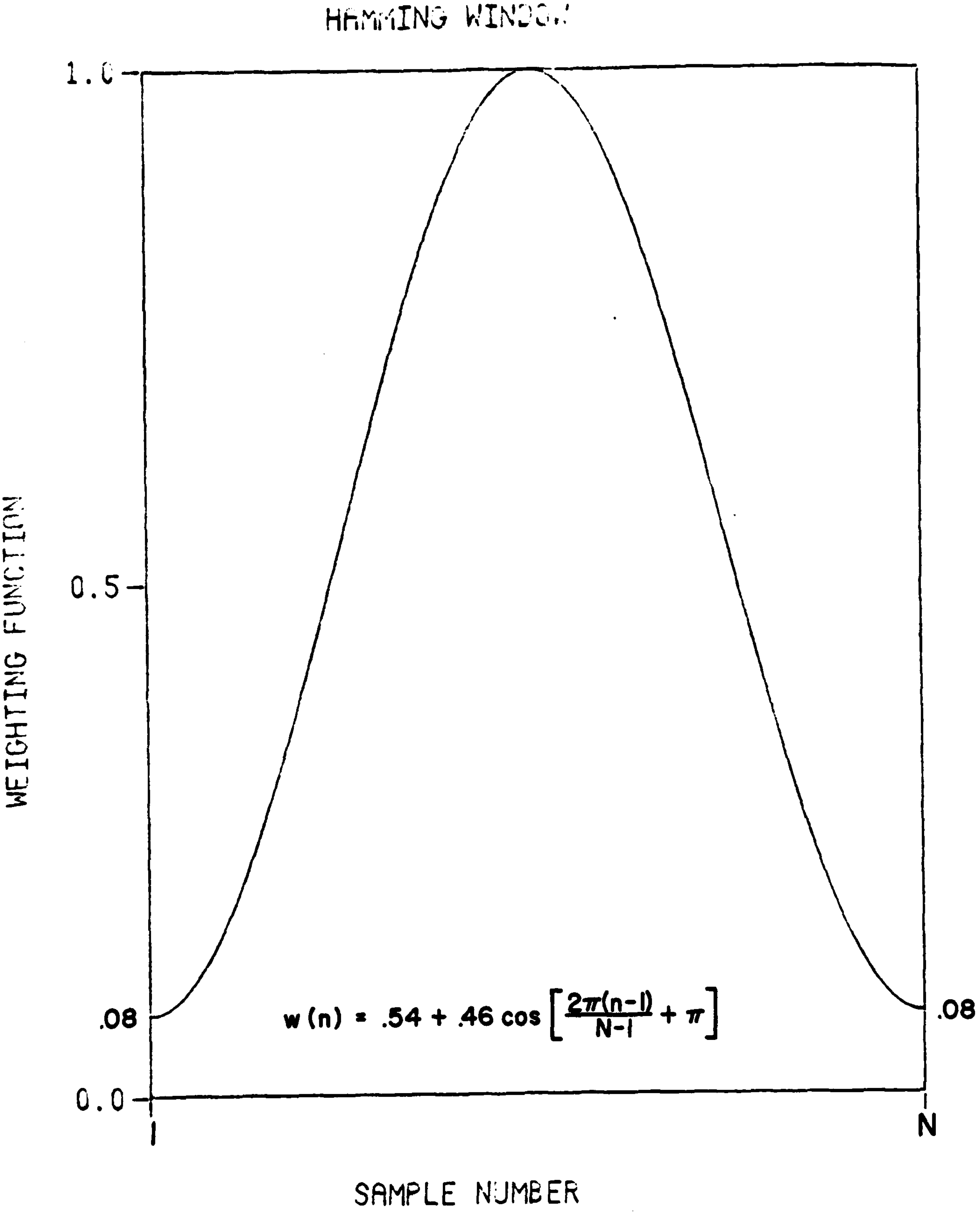
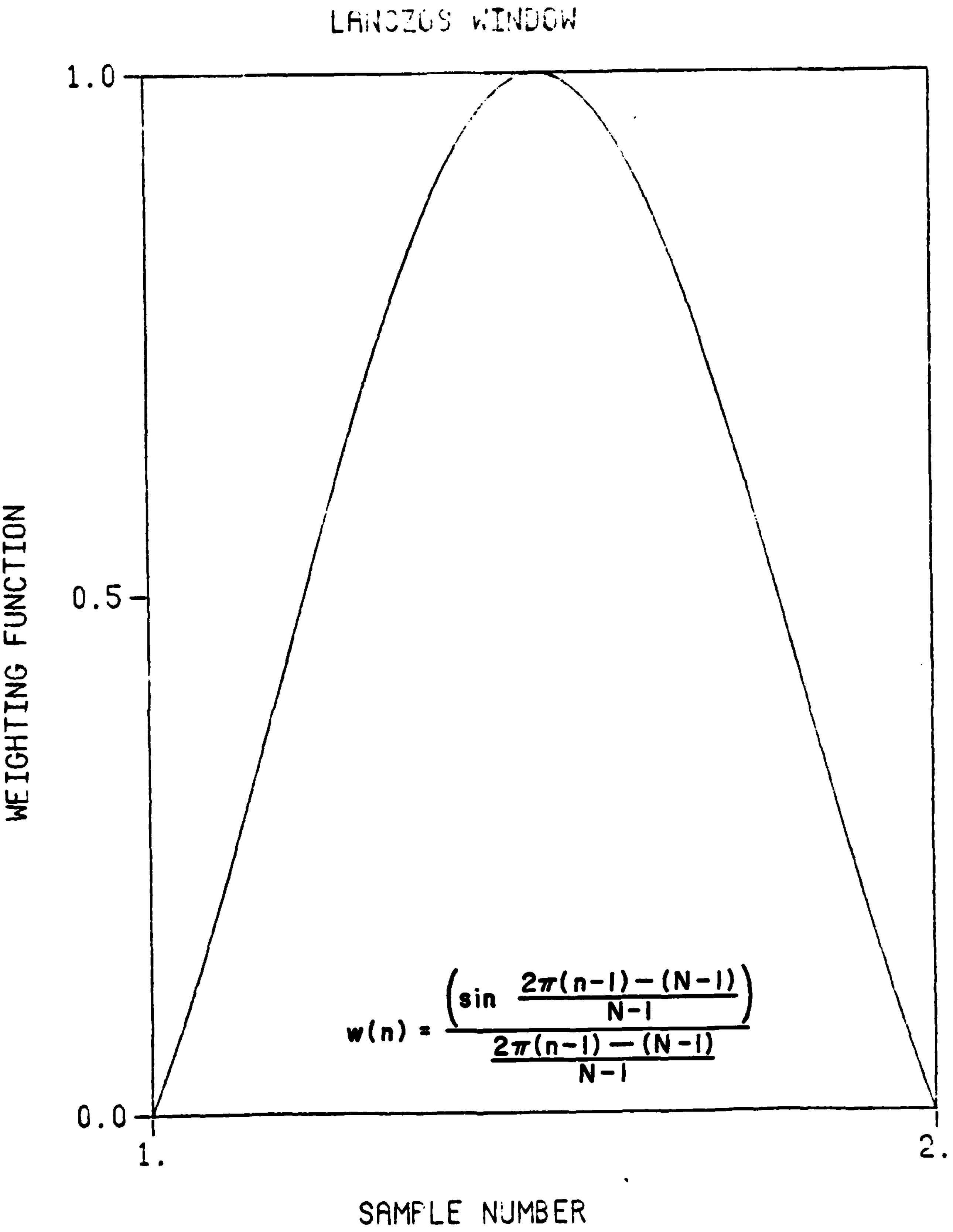
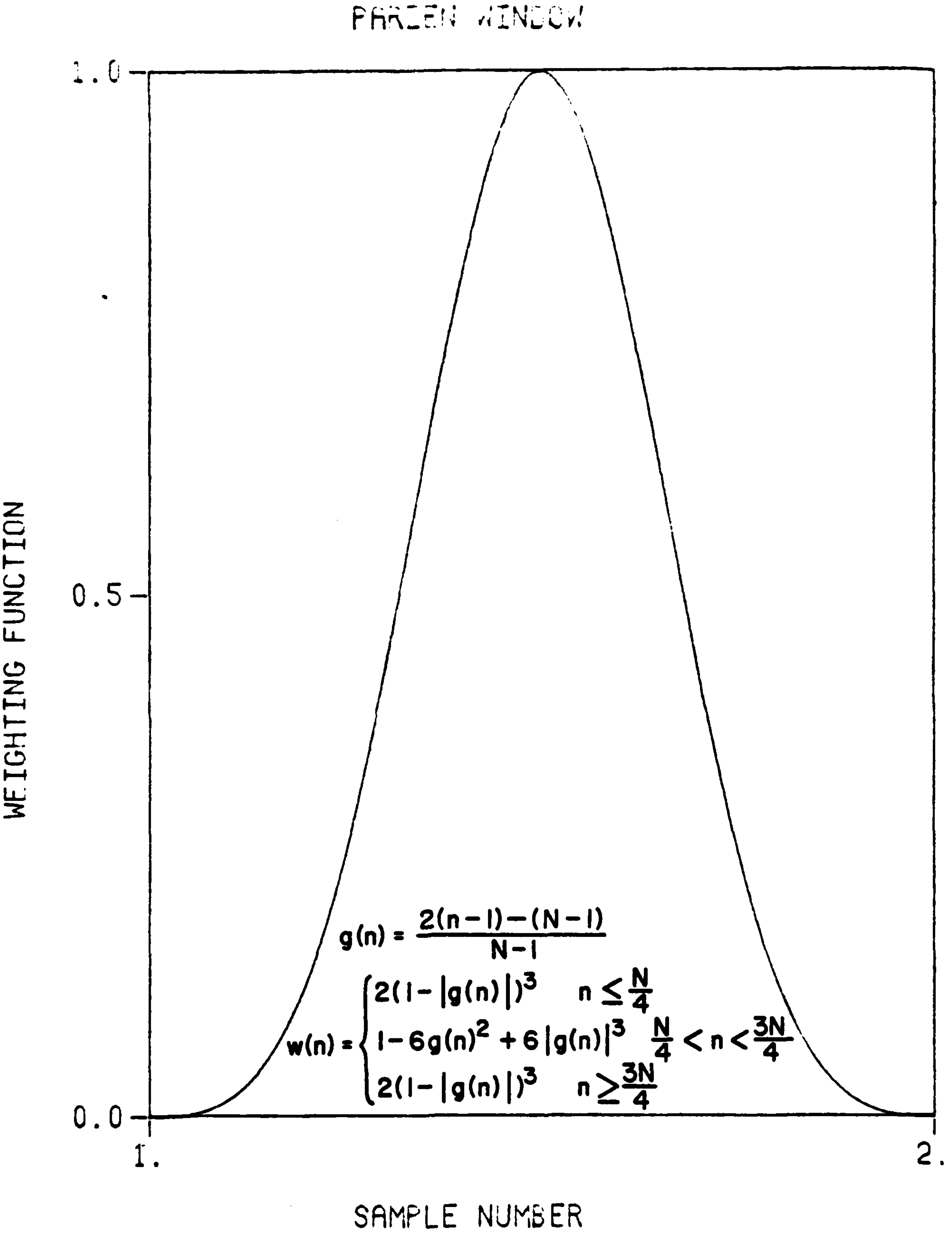

HAMMING WINDOW
1.0
0.5
.08
0.0
.08
$w(n) = .54 + .46 \cos\left[\frac{2\pi(n-1)}{N-1} + \pi\right]$
WEIGHTING FUNCTION
1
N
SAMPLE NUMBER

Figure 3.



$$w(n) = \frac{\left(\sin \frac{2\pi(n-1)-(N-1)}{N-1}\right)}{\frac{2\pi(n-1)-(N-1)}{N-1}}$$

Figure 4.



$$g(n) = \frac{2(n-1)-(N-1)}{N-1}$$

$$w(n) = \begin{cases} 2(1-|g(n)|)^3 & n \leq \frac{N}{4} \\ 1-6g(n)^2+6|g(n)|^3 & \frac{N}{4} < n < \frac{3N}{4} \\ 2(1-|g(n)|)^3 & n \geq \frac{3N}{4} \end{cases}$$

Figure 5.

Therefore

$$y(t) = C_n\, e^{i\omega_n t} \left[e^{i\omega_n h} -1 \right]$$

Taking the Fourier transform of both sides results in:

$$Y = \left[e^{i\omega_n h} -1 \right] X \, .$$

where Y and X are the Fourier transforms of y and x. The spectral density functions G_{yy} and G_{xx} are proportional to Y*Y, and X*X, thus:

$$G_{yy} \doteqdot 2(1 - \cos \omega_n h)\, G_{xx}$$

and employing the identity $\sin^2 \; = \; \frac{1}{2}(1 - \cos 2 \;)$ we get

$$G_{yy} \doteqdot 4 \sin^2 \frac{\omega_n h}{2}\, G_{xx} \, .$$

Since $\omega_n \frac{2\pi n}{T}$, n= o, 1, 2, --- N-1, the frequency response for the first difference pre-whitening filter is:

$$R(n) = 4 \sin^2 \frac{\pi n h}{T} = 4 \sin^2 \frac{\pi n}{N}$$

Thus it varies from zero at n = o to 4 at n = N/2, the Nyquist frequency. Since the pre-whitening response function for spectral estimates (auto and cross) is real, a correction may be performed by scalar multiplication in the frequency domain by its inverse. This correction procedure is called post-coloring.

2.6 Averaging

Unaveraged spectral estimates computed in the manner described for Gaussian random variables are distributed as chi-squared random variables with two degrees of freedom. Frequency averaging is employed in one of three ways to increase the number of degrees of freedom thereby enabling confidence intervals to be placed about the spectral estimates. The three choices are termed convolution, block, and combination averaging. The first involves a unit boxcar of bandwidth $(2nn + 1)/N'h$ with the raw spectrum (or periodigram), where nn is the number of adjacent fundamental bands to be averaged on each side of the center band, N' is the augmented number of samples (LTRANS) and h is the sampling interval (STEP). This results in a nominal number of degrees of freedom $\nu = 2BT = (2)(2nn + 1)(N/N')$. Nominal is emphasized; the actual number of degrees of freedom depends upon an effective bandwidth and an effective record length T both of which are usually somewhat less than the nominal ones used above as discussed by Blackman and Tukey (1956). Generally, the nominal values will suffice if a modest taper like a 10% cosine is employed and if the smoothed spectrum is fairly uniform over the averaging bandwidth.

2.7 Confidence Interval and Significance Levels

Confidence interval multipliers at the 90% level are printed and plotted for each choice of averaging. These specify the upper and lower limits of the true spectrum with 90% confidence given the estimated spectrum. They are obtained using standard tables for a chi-squared distribution.

The 90% significance level for the null hypothesis on the various estimates of coherence squared (rotary, maximum, minimum, and stability) are printed for each choice of averaging. The null hypothesis that the true coherence is zero can be rejected with 90% confidence is the estimated coherence squared lies above the significance level. Values were obtained by linear least squares fit to the conditional distribution function for sample coherence given that the true coherence is zero as tabulated by Amos and Koopmans (1963).

2.8 Sample Products

The following three figures (6 through 8) show sample products from RSPEC and RCSPEC. Figure 6 shows the anticlockwise and clockwise spectra overplotted on a log-log scale with their associated confidence intervals. Figure 7 shows, from top to bottom, the semiminor to semimajor axis ratio, principal axis orientation, ellipse stability, and maximum and minimum coherence squared. Figure 8 shows the rotary coherencies squared and phase differences for a pair of vector times series computed by RCSPEC.

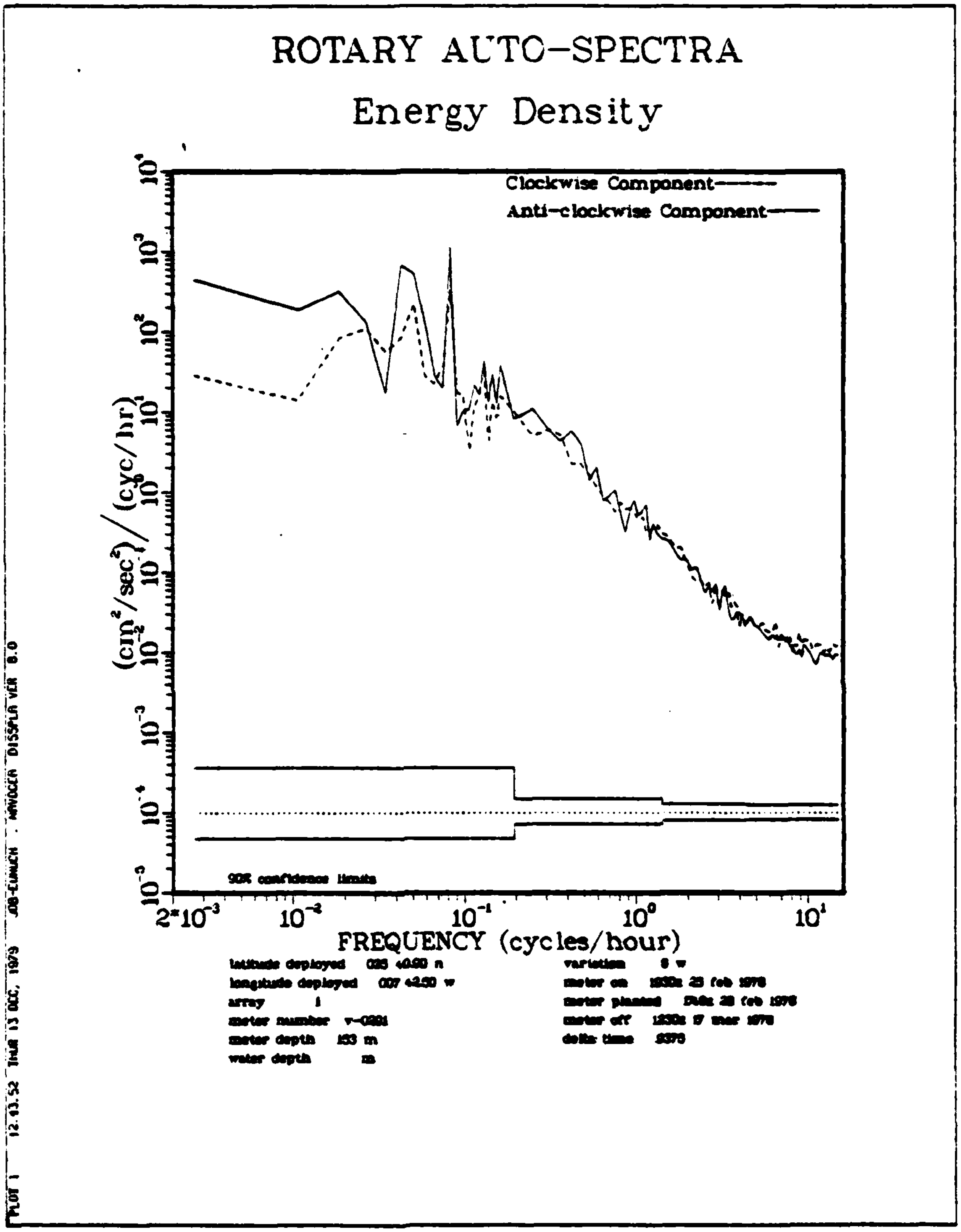


Figure 6. Sample output for rotary spectral analysis program showing energy density plot.

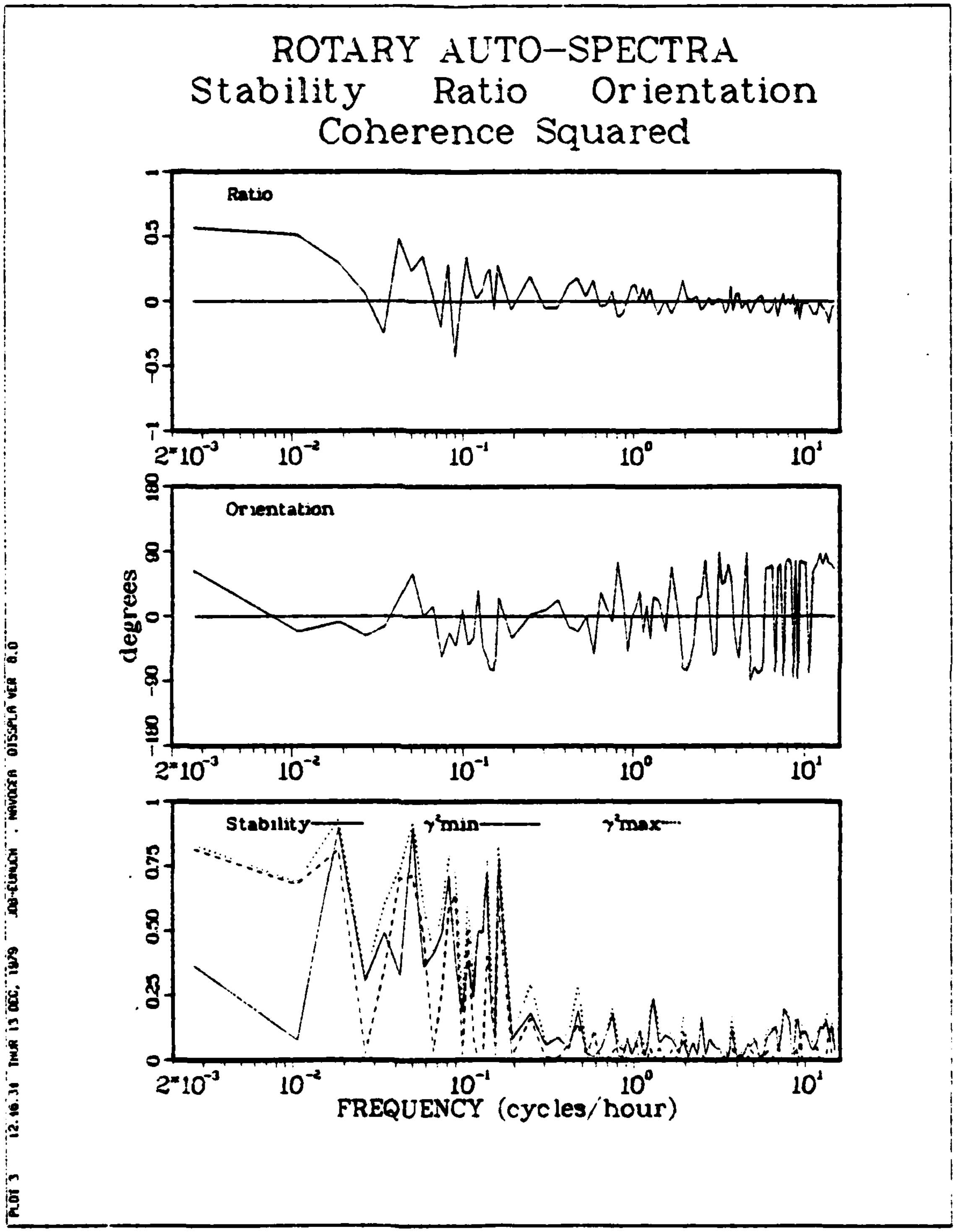


Figure 7. Sample output for rotary spectral analysis program showing hodograph ellipse parameters.

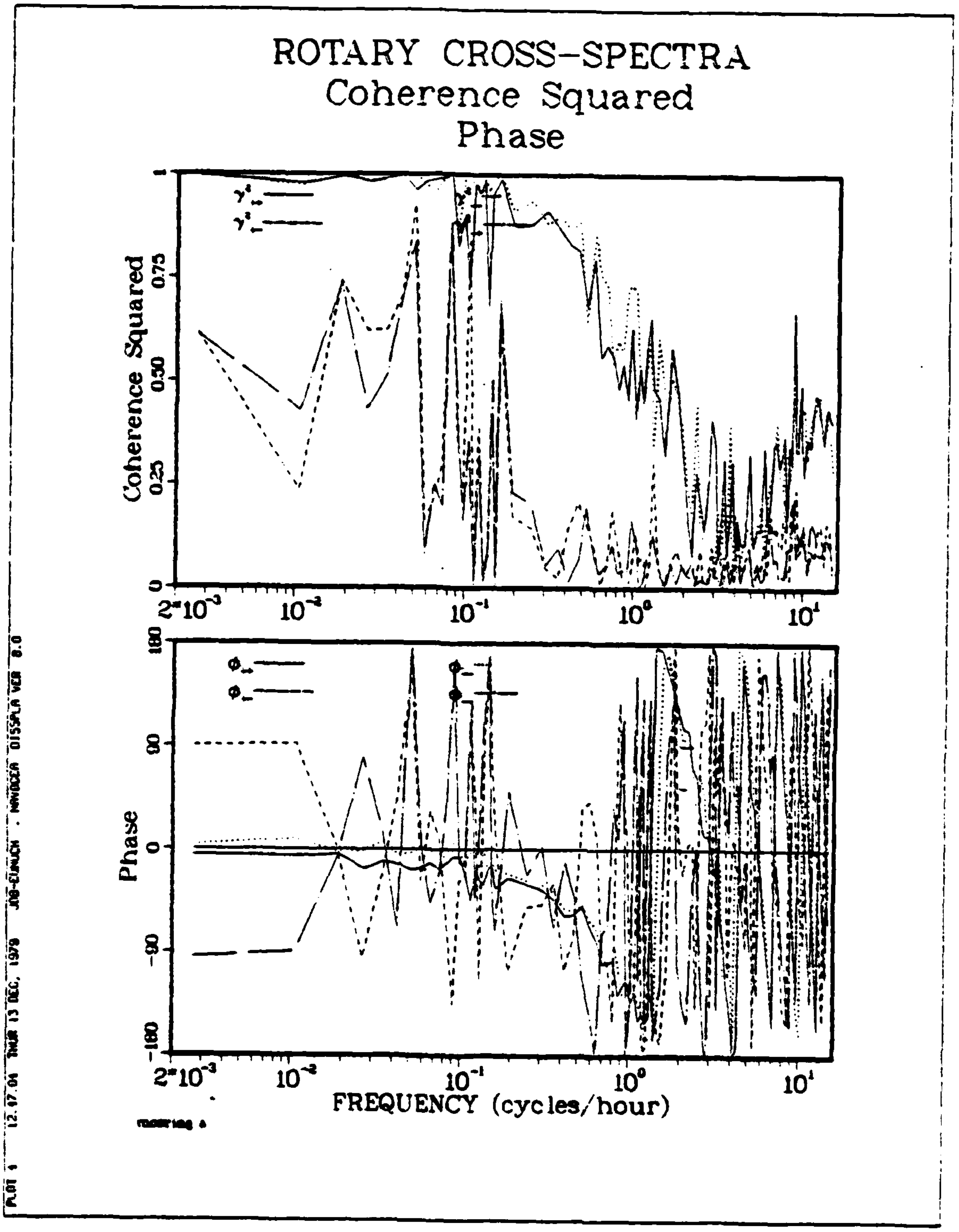


Figure 8. Sample output for rotary spectral analysis program showing plots of cross-spectral products: coherence squared and phase.

3.0 DESCRIPTION OF DATA ANALYSIS PROGRAMS

3.0 DESCRIPTION OF DATA ANALYSIS PROGRAMS

3.1 GET

The GET program should be utilized to remove time series data from a Febfile and store it in datasets which can be accessed by the FOURCO program. The following is a brief discussion of the minimal amount of information necessary to use the GET program. For a more detailed description, contact David Hale (Ext. 4241).

Input Parameters

The Febfile dataset first must be assigned to unit 4. The first input line is read with a format of (A6, 6I5, 2F5.0, A6). These parameters are:

ITYPE Denotes the type of current meter used. The choices are:

AANDER
CTD
TWDCTD
VACM

IBGN The beginning segment for the data desired.

IEND The ending segment for the data desired.

IBGCY The first cycle to read in the beginning segment.

IPTS The total number of data estimates to be stored in the output datasets.

ITV The interval or decimation factor. A value of 2 means every other point will be used. For example, every fourth point will be used if a value of 4 is supplied.

IFILT The type of filter to use:

0 No filter
1 Lopass filter
2 Hipass filter

FREQ
DELT
DETND These parameters are optional and are not necessary for executing GET. Use of these paramenters should be with guidance of appropriate NAVOCEANO personnel only.

The second parameter card is read with a format of (16I5).

NPAIRS The number of variables to be stored. Always use 2 for both components of velocity.

IVAR (I)
IUN (I) These parameters are paired and there should be NPAIRS of them. IVAR represents the variable to output and IUN is the FORTRAN unit reference number that will be associated with the dataset. The GET program allocates these files so the user is not required to do so.

Time series data is stored in a FEBFILE in u, v component pairs. The FOURCO program requires four input datasets: a v and u component from each of two time series. The v component from the first current meter should be associated with file 7 and the u component with file 8. The v and u components of the second time series should correspond to units 9 and 10, respectively. For example, after first moving the FEBFILE from tape to a file named 'FEBFILE,' the following should be entered:

```
@ USE    4, FEBFILE.
@ XQT    JAY.GET
VACM       1    4  200 4000    1    0
    2      2    7    1    8
```

After a message is printed saying that processing is complete, the program should be executed again to create files 9 and 10.

Should the user desire to examine the header label of a particular segment of a FEBFILE, he can use GET. The header label is output to each of the output datasets so, by editing them, the user can print the label. To save execution time, the value for IPTS may be entered as a zero and NPAIRS may be set to one.

3.2 FOURCO

FOURCO generates complex Fourier coefficients given two sets of time series data. The Singleton Fast Fourier Transform (IEEE Transactions on Audio and Electroacoustics, June, 1969) is incorporated which allows for a wide range of transform lengths. If the user desires, the data may be pre-whitened, and the capability to apply a variety of spectral windows is included.

Input consists of four datasets: one u and v component from each of two time series. Fortran unit number 7 should correspond to the v component of the first time series. The u component of the same time series is referenced by unit number 8. Units 9 and 10 correspond to the v and u components, respectively, of the second time series. All of these datasets should be originally generated from Febfile using the GET program. In addition to these datasets, some parameters are also necessary. They are explained below. The Fourier coefficients are output to units 17, 18, 19 and 20 for use by the RSPEC and RCSPEC programs. Printed output includes the mean and mean square values for each dataset and the header information from each of the Febfiles accessed.

Input Parameters

The following parameters must be supplied by the user after a prompting message is printed. The format is (3I10).

LTRANS The length of the fast Fourier transform to apply. The maximum prime factor is 23 and the size is usually limited by the computer involved. For a more detailed discussion of transform lengths, refer to Singleton's paper.

NWINDO Denotes which spectral window to apply to the time series:

0 Boxcar (NO) window
1 10% Cosine window
2 Hanning window

3 Hamming window
4 Parzen window
5 Lanczos window

KWHITE Denotes if data should be pre-whitened:

0 Do not pre-whiten
1 Pre-whiten

Caution: Should pre-whitening be implemented, the user is advised to use post-coloring in both RSPEC and RCSPEC.

To execute FOURCO, simply enter @XQT JAY.FOURCO. Then enter the input parameters immediately thereafter.

3.3 RSPEC and RCSPEC

The RSPEC and RCSPEC programs are similar in that they both require the same input parameters and incorporate the same averaging schemes (a discussion of these averaging schemes appears later). However, since RSPEC analyzes one pair of u,v components and RCSPEC analyzes two pairs of u,v components, RSPEC is actually executed twice (using a simple do-loop). Therfore, two sets of input parameters are required (one following the other) and three pairs of output files are generated. Four of these files are for plotting purposes: two confidence interval files (units 14 and 15) and a pair of rotary spectral analysis files (12 and 13). Another pair of files store data printouts (22 and 23). RCSPEC outputs two files: one for plotting purposes (unit 11) and another for outputting the rotary cross spectral statistics (21). The input FOURIER coefficients datasets are assocaited with unit numbers 17, 18, 19 and 20.

One primary goal in the writing of both programs was to avoid potential core region problems. This was accomplished by swapping data in and out of arrays during the calculation of statistics and the averaging thereof. The input arrays for the Fourier coefficients (U and V in RSPEC and AU, AV, BU, BV in RCSPEC) must be large enough to store all of the FOURIER coefficients - one half the transform length plus one. However, the arrays used to store the spectral estimates (the 'G' arrays: GPP, GMM, G11, and G22 in RSPEC and the 'U' arrays: UACPBP, UACNBN, UACPBN, UACPAP, UBCPBP, UACNAN, and UBCNBN in RCSPEC) are of variable length. They must be at least greater than double the NN value (or the largest NN value if block averaging). The smaller these arrays are, the more swapping is required thus reducing turnaround time. All of these arrays are complex and also common so if the size is changed, corrections must be made in all of the subroutines that have access to them. The value of 'IASIZE' must be set to the size of the arrays.

Input Parameters

These first three parameters are read from the first record of one of the Fourier coefficient datasets. The format is (2I5,I1).

LTRANS The size of the Fourier transform applied to the time series data.

LENGTH The number of estimates in the original time series before the Fourier transform is applied.

NWINDO Denotes the spectral window used before the Fourier transform was applied.

The following parameters must be supplied by the user after a prompting message is printed. The format is (F10.0,5I10).

STEP The time increment in hours between the estimates in the original time series.

PSTCLR Denotes if the spectral estimates should be post-colored or not:

Ø Do not apply post-coloring
1 Apply post-coloring

IWSOPT Denotes whether spectral window scaling should be applied:

Ø Do not apply spectral window scaling
1 Apply spectral window scaling

IOPT Denotes the type of averaging to use:

1 Block averaging
2 Convolution averaging
3 Combination of block and convolution averaging

NN The number of adjacent frequency bands to use when convolution averaging. Not applicable when implementing only block averaging.

NUMBNN The number of NN values used when block averaging. This number must be greater than Ø and less than 31. Not applicable when only convolution averaging.

The next parameters are optional and are only required for block or combination averaging. They are pairs of ISTART and NNS values. NUMBNN pairs must be supplied after a prompting message is printed. The format is 14I5 and if more than 7 pairs are required 2 or more lines of input will be necessary.

ISTART Refers to a position in the Fourier coefficient arrays to begin calculating specific estimates for block averaging with the current NNS value supplied.

NNS The number of adjacent frequency bands to use when block averaging a particular group of spectral estimates.

Execution of RSPEC is initiated with an @XQT JAY.RSPEC. To begin the RCSPEC program, simply enter @XQT JAY.RCSPEC.

Block Averaging

Block averaging produces independent estimates. To specify block averaging, input a value of 1 for IOPT. NUMBNN is the number of NN values to use and should be greater than, or equal to, 1 and less than 31. Also, the number of ISTART and NNS pairs should equal to the value input for NUMBNN. The value of NN applies only to convolution or combination averaging and is meaningless for block averaging. NNS values specify the number of adjacent frequency bands averaged on each side of the central estimate. For example, if NNS = 2:

$$\begin{array}{ll} \text{Unaveraged Estimates} & \ldots\ \underbrace{X\ X\ X\ X\ X}\ \underbrace{X\ X\ X\ X\ X}\ X\ \ldots \\ \text{Averaged Estimates} & \ldots\qquad Y \qquad\qquad Y \qquad\quad \ldots \end{array}$$

In this example note that 5 estimates are averaged to produce one averaged estimate. The 5 new estimates are averaged for the next independent value. This will produce an averaged dataset 1/5 the length of the number of Fourier coefficients input. The ISTART values refer to the Fourier coefficient pairs to use when beginning block averaging. Often, the user will input the first ISTART value as 2 to avoid the zero frequency estimate. For example, if:

ISTART (1) = 2   NNS (1) = 2
ISTART (2) = 7   NNS (2) = 1

$$\begin{array}{ll} \text{Unaverage Estimates} & X_1\ \underbrace{X_2\ X_3\ X_4\ X_5\ X_6}\ \underbrace{X_7\ X_8\ X_9}\ \underbrace{X_{10}\ X_{11}\ X_{12}}\ X_{13}\ \ldots \\ \text{Averaged Estimates} & \qquad\qquad Y_1 \qquad\qquad\quad Y_2 \qquad\qquad Y_3 \end{array}$$

If NUMBNN is equal to 2, the rest of the estimates will be averaged in blocks of three. The printout will print the corresponding periods and freqencies for each value. Note in the previous example that if ISTART (2) had equaled 8, estimate #7 would have not been averaged at all. Care should be taken to avoid this situation. Block averaging offers the user the capability to use different NN values and therefore to vary the numbers of degrees of freedom with frequency. To relate the ISTART values to specific frequencies, one could first run the data through the same program implementing convolution averaging. The sequence numbers generated correspond to ISTART values. Any RSPEC or RCSPEC output that used convolution averaging and used the same transform length and step value will contain sequence numbers applicable to all other datasets using like transform lengths and steps. NNS values may be repeated and

Ø may be used when unaveraged estimates are desired. However, should unaveraged estimates be desired for the first frequency bands (the low frequency end) use combination averaging (see next section) with NN equal to Ø. If unaveraged estimates are desired for all frequencies use convolution averaging with NN equal to Ø.

Convolution Averaging

Convolution, or running, averaging maintains resolution by sampling each point in the frequency domain. To specify convolution averaging, input a value of 2 for IOPT and any value greater than, or equal to, Ø for NN. Any value specified for NUMBNN is meaningless and no input is required for the INSTART and NNS arrays. NN specifies the number of adjacent frequency bands to be used in averaging on each side of the central estimate. For example if NN = 2:

Unaveraged Estimates	$X_1\ X_2\ X_3\ X_4\ \ldots$
New Unaveraged Estimates	$X_3\ X_2\ X_1\ X_2\ X_3\ X_4\ \ldots$
Averaged Estimates	$Y_1\ \ Y_2$

The same method is used with the last estimates. Therefore, when convolution averaging, the same number of values are output as the number of Fourier coefficient pairs input. Should the user not desire any averaging, an NN value of Ø will produce unaveraged periodigram estimates.

Combination Averaging

Combination averaging allows the user to incorporate both convolution and block averaging. An IOPT value of 3 specifies convolution averaging. Appropriate values must be input for NN, NUMBNN, and the ISTART and NNS arrays. Convolution averaging must be implemented first on the low frequency end of the estimates and then block averaging is used for the rest of the estimates. Convolution averaging involves the first ISTART (1) - 1 estimates. Values are "folded" around the first estimate but not where block averaging begins. For example, if:

NN = 1
INSTART (1) = 5
NNS (1) = 2

Unaveraged Estimates $X_2\ X_1\ X_2\ X_3\ X_4\ \underbrace{X_5\ X_6\ X_7\ X_8\ X_9}\ \underbrace{X_{10}\ X_{11}\ X_{12}\ X_{13}\ X_{14}}\ \ldots$

Averaged Estimates $Y_1\ Y_2\ Y_3 \qquad Y_4 \qquad Y_5 \qquad \ldots$

This would continue for the remainder of the dataset. NN and NNS values may be any number greater than or equal to zero. NUMBNN must be 30 or less. The first ISTART value should be large enough to allow for the desired amount of convolution averaging and other ISTART values should be chosen carefully to involve all estimates in the averaging.

4.0 COMPREHENSIVE RUNSTREAM

4.0 COMPREHENSIVE RUNSTREAM

To simplify its operation, all of the components of this package have been combined into one runstream. The user is required only to copy the desired Febfile from tape into a dataset named 'FEBFILE.' Then he simply enters, '@ADD JAY.RUNALL' and the entire package is executed. The runstream assigns all necessary files and even deletes old files referred by the same file names. Afterwards, the printed output from RCSPEC can be referenced by FORTRAN unit 21 and the two RSPEC printouts are assocated with units 22 and 23. If desired, these may be routed to a printer.

The input parameters to the various programs may be altered by editing the 'JAY.RUNALL' file. Also, should the user desire to analyze the data from two different Febfiles, a slight modification would be necessary. For example, the Feb files would have to be copied to two different data sets and another '@USE' statement should be placed before the second '@XQT JAY.GET' command.

5.0 DESCRIPTION OF PLOTTING PROGRAM

5.0 DESCRIPTION OF PLOTTING PROGRAMS

The graphics output program is written in four sections each of which controls a different plot.

FIRST PLOT

THIS PROGRAM SEGMENT PLOTS THE CLOCKWISE AND ANTICLOCKWISE COMPONENTS OF ENERGY DENSITY ON A SINGLE COORDINATE FRAME. 90% CONFIDENCE LIMITS ARE PLOTTED ON THE SAME AXIS SYSTEM USING A DECADE LINE AS REFERENCE BASE.

NOTE: IF USER DOES NOT SPECIFY A LOG-LOG AXIS SET-UP (NPL (1) =3 OR -3), CONFIDENCE LIMITS PLOT WILL APPEAR DISTORTED.

SECOND PLOT

THIS PROGRAM SEGMENT PLOTS THE SAME INFORMATION AS THE FIRST PLOT. THE FORMAT IS CHANGED, HOWEVER, SO THAT THE CLOCKWISE AND ANTICLOCKWISE COMPONENTS ARE PLOTTED ON SEPARATE COORDINATE FRAMES.

THIRD PLOT

THIS PROGRAM SEGMENT PLOTS VARIOUS HODOGRAPH PARAMETERS FOR ROTARY AUTO-SPECTRAL DATA.

- THE LOWER FRAME CONTAINS PLOTS OF STABILITY AND MAXIMUM AND MINIMUM COHERENCE SQUARED VS. FREQUENCY
- THE MIDDLE FRAME CONTAINS A PLOT OF ORIENTATION (IN DEGREES) VS. FREQUENCY
- THE UPPER FRAME CONTAINS A PLOT OF RATIO VS. FREQUENCY

FOURTH PLOT

THIS PROGRAM SEGMENT PLOTS ROTARY CROSS SPECTRAL DATA ON TWO COORDINATE FRAMES:

- THE UPPER FRAME CONTAINS PLOTS OF THE VARIOUS COHERENCIES (SQUARED) OF CLOCKWISE AND ANTICLOCKWISE COMPONENTS AT THE TWO MOORINGS AS FUNCTIONS OF FREQUENCY
- THE LOWER FRAME CONTAINS PLOTS OF THE CORRESPONDING PHASES

NOTATIONAL CONVENTIONS:

(++) =>	ANTICLOCKWISE AT A	ANTICLOCKWISE AT B
(+-) =>	ANTICLOCKWISE AT A	CLOCKWISE AT B
(--) =>	CLOCKWISE AT A	CLOCKWISE AT B
(-+) =>	CLOCKWISE AT A	ANTICLOCKWISE AT B

One of the most important aspects of this plotting package is user control. The user can exercise the following options:

1. Which of the four available plots will be drawn.

On the plots to be drawn:

2. What titles and labels will appear on the plot.
3. What type of axis scaling will be used.
4. Whether, or not, mooring data will be included on the plot.
5. *The number* of data points which will be plotted.

These options are exercised by means of a control file containing records on card images in (10I5) format. Basically the first card controls option 2; the second controls options 1 and 3; and the remaining cards control options 4 and 5.

USER CONTROL OF THE GRAPHICS OUTPUT IS ACCOMPLISHED VIA TWO DATA SETS WHOSE FORTRAN REFERENCE NUMBERS ARE CALLED KU AND KD IN THE MAIN PROGRAM. KU CONTAINS CONTROL DATA AND KD CONTAINS USER SUPPLIED LABELS (SEE TABLE 1 FOR LIST OF AVAILABLE LABELS).

KU (ALL RECORDS ARE 15I5 FORMAT)

FIRST CARD - ONE FIELD READ (ENTERS AS KLAB)

FIELD CONTAINS:

1	=>	USER SUPPLIED LABELS ARE TO BE READ INTO ARRAY ICAT FROM KD
0	=>	NO USER LABELS SUPPLIED

TABLE 1. LIST OF AVAILABLE LABELS

Item		Label
1	-	(FREQUENCY (cycles/hour))
2	-	((cm^2/sec^2)/(cyc/hr))
3	-	(Energy Density)
4	-	(Clockwise Components)
5	-	(Anticlockwise Components)
6	-	(ROTARY AUTO-SPECTRA)
7	-	(Maximum and Minimum Coherence Squared)
8	-	(Stability Ratio Orientation)
9	-	(degrees)
10	-	(max)
11	-	(min)
12	-	(Stability)
13	-	(ROTARY CROSS-SPECTRA)
14	-	(Orientation)
15	-	(Coherence Squared)
16	-	(-)
17	-	(———)
18	-	(•••••)
19	-	(-----)
20	-	(—•—)
21	-	(γ^2)
22	-	(ϕ)
23	-	($_{++}$)
24	-	($_{--}$)
25	-	($_{+-}$)
26	-	($_{-+}$)
27	-	(Ratio)

SECOND CARD - FOUR FIELDS READ (ENTERS AS NPL (1) - (4))

THE FOUR FIELDS CORRESPOND IN ORDER TO THE FOUR PLOTS

FIELD CONTAINS:

0	=>	CORRESPONDING PLOT NOT DRAWN
NEG. NUMBER	=>	CATALOG OF USER SUPPLIED LABELS TO BE USED FOR THE CORRESPONDING PLOT
POS. NUMBER	=>	DEFAULT CATALOG TO BE USED FOR THE CORRESPONDING PLOT

NUMBER WHOSE ABSOLUTE VALUE IS 1	=>	X-AXIS LOG	Y-AXIS LINEAR
2	=>	X-AXIS LINEAR	Y-AXIS LINEAR
3	=>	X-AXIS LOG	Y-AXIS LOG

REMAINING CARDS - NINE FIELDS READ (ENTERED AS NBOT, NPTS, AND IT (1) - (7))

THE REMAINING CARDS CORRESPOND IN ORDER TO THE PLOTS WHICH ARE TO BE DRAWN

FIELD #1 CONTAINS

0	=>	MOORING DATA NOT INCLUDED ON PLOT
1	=>	MOORING DATA APPEARS ON PLOT

FIELD #2 CONTAINS THE NUMBER OF DATA POINTS WHICH THE PLOT WILL CONTAIN. IF THIS FIELD IS ZERO OR BLANK, THE PROGRAM WILL ASSUME ALL POINTS ARE TO BE INCLUDED.

FIELDS #3 - 9 WILL ONLY BE READ IF USER SUPPLIED LABELS ARE TO BE USED IN THE CORRESPONDING PLOT. THE PROGRAM READS THESE VALUES INTO ARRAY IT. SEE DOCUMENTATION OF ROUTINES TOP AND SETUP FOR FURTHER EXPLANATION.

KD (ALL RECORDS ARE 12A6 FORMAT)

EACH RECORD SHOULD CONTAIN A CHARACTER STRING NOT TO EXCEED 71 CHARACTERS FOLLOWED BY "$". THESE STRINGS WILL BE WRITTEN USING THE ALPHABET CONVENTIONS OF SUBROUTINE ALFSET, I.E., INSTRUCTIONAL STRING OPTIONS ARE AVAILABLE.

NOTE: KD SHOULD CONTAIN NO MORE THAN 15 RECORDS

EXAMPLE:

SUPPOSE DATA SET KU CONTAINS THE FOLLOWING CARDS

```
1
3      0  0   -1
1   3500
0   4098   1    2    3   4    2   5
```

THE PROGRAM WOULD:

- READ THE LABELS FROM KD INTO ICAT
- DRAW THE FIRST PLOT USING DEFAULT TITLE AND LABELS ON A LOG-LOG AXIS
- USE ONLY THE FIRST 3500 FREQUENCY VALUES AND INCLUDE MOORING DATA AT THE BOTTOM OF THE FIRST PLOT
- DRAW THE FOURTH PLOT ON A LOG-LINEAR AXIS USING THE FIRST THREE RECORDS FROM KD AS THE LINES OF TITLE, THE FOURTH RECORD AS X-AXIS LABEL, AND THE SECOND AND FIFTH RECORDS AS Y-AXIS LABELS
- THE FOURTH PLOT WOULD USE 4098 POINTS AND WOULD NOT CONTAIN ANY MOORING INFORMATION

FORTRAN REFERENCE NUMBERS FOR DATA SETS ARE:

KR	ROTARY DATA
KRX	ROTARY CROSS DATA
KCI	CONFIDENCE INTERVAL DATA
KDD	DEFAULT LABELS CATALOG
KF	DATA SET CONTAINING CURRENT METER INFORMATION
KU	USER CONTROL CARDS
KD	USER SUPPLIED LABELS CATALOG

Following is an explanation of the internal sizing parameters which control the physical dimensions of the plots. These parameters are preset, based on the assumption that plots will be on an 8 1/2" x 11" frame which would be suitable for publication. Sizing parameters can be changed to create plots of any desired size and are limited only by the capabilities and physical dimensions of the plotter itself. There are four parameters:

P   TOTAL HORIZONTAL SIZE OF THE SPACE WHICH WILL BE DEDICATED TO AXIS FRAMES.

Q   TOTAL VERTICAL SIZE OF THE SPACE WHICH WILL BE DEDICATED TO AXIS FRAME(S). THIS DOES NOT INCLUDE SPACE FOR TITLE OR STORY.

G SIX OF THE VERTICAL SEPARATION OF GRAPH FRAMES WHEN THERE IS MORE THAN ONE FRAME PER PAGE.

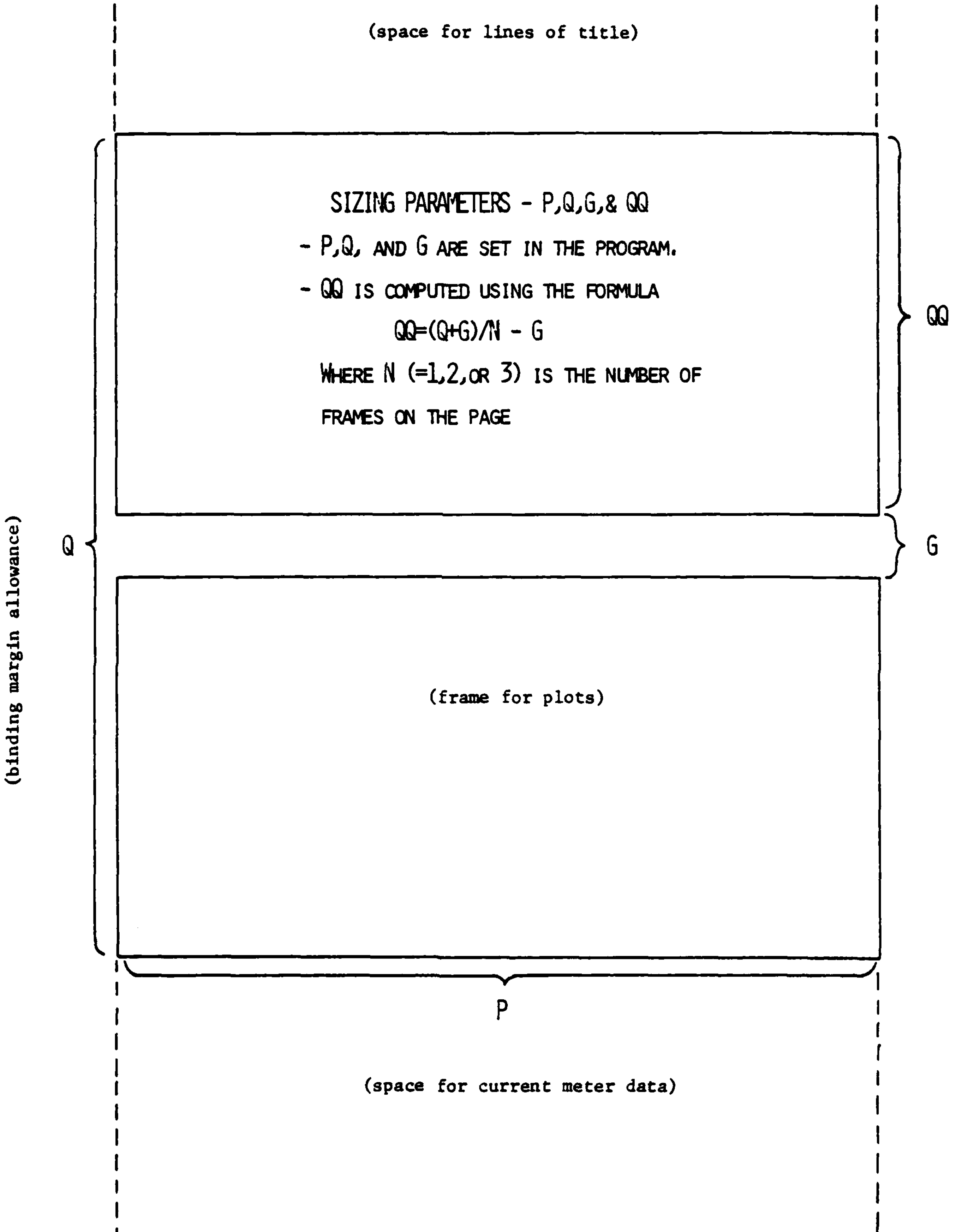
XPOS,YPOS HORIZONTAL AND VERTICAL DISTANCES SEPARATING THE PHYSICAL ORIGIN OF THE LOWEST PLOT FRAME FROM THE LOWER LEFT CORNER OF THE PAGE.

The present values for these parameters are*:

```
P=6.
Q-6.5
G=.5
XPOS=1.5
YPOS=3.0
```

Figure 9 shows the relationship of the various parameters and introduces the additional parameter QQ which is internally calculated based on the values of Q, G, and N selected by the user.

* All values are in inches.


(space for lines of title)
QQ
Q
G
(binding margin allowance)
(frame for plots)
P
(space for current meter data)

SIZING PARAMETERS - P,Q,G,& QQ

- P,Q, AND G ARE SET IN THE PROGRAM.
- QQ IS COMPUTED USING THE FORMULA

$$QQ=(Q+G)/N - G$$

WHERE N (=1,2,OR 3) IS THE NUMBER OF FRAMES ON THE PAGE

Figure 9. Relationship of Sizing Parameters

APPENDICES

A. Source Listing - Data Analysis Programs
B. Source Listing - 'JAY.RUNALL'
C. Source Listing - 'MAP' Dataset Listings
D. Source Listing - 'JAY.USER'
E. Source Listing - Plotting Program

APPENDIX A - SOURCE LISTINGS

DATA ANALYSIS PROGRAMS

I. GET

II. FOURCO
   A. MAIN PROGRAM
   B. SUBPROGRAMS
      1. FFT
      2. PWHITE
      3. WINDOW

III. RSPEC
   A. MAIN PROGRAM
   B. SUBPROGRAMS
      1. CALC
      2. SWAP
      3. AVRG
      4. BAVRG
      5. STAT
      6. SL
      7. CONINT

IV. RCSPEC
   A. MAIN PROGRAM
   B. SUBPROGRAMS
      1. CALC
      2. SWAP
      3. AVRG
      4. BAVRG
      5. PHACOH
      6. SL

I. GET

```
      COMPILER(DIAG=3)
      CALL GETDAT
      STOP
      SUBROUTINE GETDAT
      COMMON/DIAGS/MSGR,MSGW,NNNR,NNNW,NNIP,NNA,NNI,NNF,IRST,IWST
      COMMON/XD/LF1,LF2,NPAIRS,IVAR(10),IUN(10),ICT(10)
      DIMENSION NTYPE(5),ICYCLS(5),INUM(5)
      DATA NTYPE/6HAANDER,6HCTD   ,6HTWDCTD,6HVACM  ,6H TEST /
      DATA ICYCLS/1660,3000,1000,3000,3000/INUM/6,3,10,3,3/
      DATA NNI,NNA,NNF/100,100,100/
      READ(5,10) ITYPE,IBGN,IEND,IBGCY,IPTS,ITV,IFILT,FREQ,DELT,DETND
   10 FORMAT(A6,6I5,2F5.0,A6)
      READ(5,15) NPAIRS,(IVAR(I),IUN(I),I=1,NPAIRS)
   15 FORMAT(16I5)
      CALL FILGEN(ITV,IFILT,DELT,FREQ)
      DO 25 I=1,5
   25 IF(ITYPE.EQ.NTYPE(I)) I1=I
      NNNR=ICYCLS(I1)
      NNIP=INUM(I1)
      CALL BREAK(IBGN,IEND,IBGCY,IPTS,ITV)
      IF(ITV.GT.1.OR.IFILT.NE.0) CALL FILTER(ITV,IFILT,IBGCY)
      IF(DETND.EQ.6HDETRND) CALL DETRND
      WRITE(6,90)
   90 FORMAT(/,5X,'** DATA RETRIEVAL COMPLETE, READY FOR PROCESSING')
      CALL ERTRAN(6,'@FREE 2. . ')
      RETURN
      SUBROUTINE FILGEN(ITV,IFILT,DELT,FREQ)
      COMMON/XD/LF1,LF2-NPAIRS
      COMMON/FILL/FILT(201),FILT1(201),SER(201)
      LF1=101
      IF(IFILT.EQ.0) LF1=1
      LF2=101
      IF(ITV.EQ.1) LF2=1
      IF(ITV.EQ.1) GO TO 10
      FITV=1./FLOAT(ITV)
      CALL GENFLT(LF2,2,1,5,FITV,FILT)
   10 CONTINUE
      IF(IFILT.EQ.0) GO TO 15
      DD=DELT*(1./60.)*FLOAT(ITV)*FREQ*2.
      CALL GENFLT(LF1,2,IFILT,5,DD,FILT1)
   15 CONTINUE
      RETURN
       SUBROUTINE GENFLT(M,JA,JB,JC,F,SER)
      WRITE(6,6666)M,JA,JB,JC,F
 6666 FORMAT(' GENFLT: M=',I6,'  JA=',I3,'  JB=',I3,
     *   '  JC=',I3,'  F=',G12.6)
       DIMENSION SER(1)
```

GET (CONT'D.)

```
      PI=3.14159265
      FM=M
      DO 100 I=1,M
      FI=I
      U=(FI-1.)/FM
      GO TO(40,50,60,61,61),JC
   61 IF(U-.00000001)40,40,63
   63 IF(JC-4)64,64,65
   64 SER(I)=  SIN(PI*U)  /(PI*U)
      GO TO 70
   65 SER(I)=(SIN(PI*U)/(PI*U))**2
      GO TO 70
   40 SER(I)=1.-U
      GO TO 70
   60 SER(I)=.5*(1.+COS(PI*U))
      GO TO 70
   50 IF(ABS(U)-.5)51,52,52
   51 SER(I)=1.-6.*U**2+6.*ABS(U**3)
      GO TO 70
   52 SER(I)=2.*(1.-ABS(U))**3
   70 IF(F-.00000001)100,100,71
   71 IF(ABS(PI*(FI-1.)*F)-.00001)100,100,73
   73 SER(I)=SER(I)*SIN(PI*(FI-1.)*F)/(PI*(FI-1.)*F)
  100 CONTINUE
  102 IF(JB)130,130,103
  103 SUM=.5*SER(1)
      DO 104 I=2,M
  104 SUM=SUM+SER(I)
      DO 129 I=1,M
  110 SER(I)=SER(I)/(2.*SUM)
      IF(JB-1)129,129,120
  120 SER(I)=-SER(I)
      IF(I-1)129,121,129
  121 SER(I)=SER(I)+1.
  129 CONTINUE
  130 JAQ=JA+2
      GO TO(150,150,140,180),JAQ
  140     CONTINUE
      RETURN
  150 MB2=M/2
      DO 155 I=1,MB2
      X=SER(I)
      II=M-I+1
      SER(I)=SER(II)
  155 SER(II)=X
      RETURN
  180 MM=2*M-1
CQ    WRITE(6,6900)(I,SER(I),I=1,MM)
 6900 FORMAT(I5,G12.6)
      DO 185 I=M,1,-1
      II=I+M-1
```

GET (CONT'D.)

```
185 SER(II)=SER(I)
    MM1=M-1
    DO 191 I=1,MM1
    II=MM-I+1
191 SER(I)=SER(II)
    RETURN
    SUBROUTINE BREAK(IBGN,IEND,IBGCY,IPTS,ITV)
    COMMON/RHDR/LR,NR,NBR,NMBR,NMFR,NFR,NIR,NAR,IPR(10)
    COMMON/RDATA/VR(10000)
    COMMON/RDOCI/IDOCR(100)
    COMMON/RDOCF/FDOCR(100)
    COMMON/RDOCA/ADOCR(100)
    COMMON/DIAGS/MSGR,NSGW,NNNR,NNNW,NNIP,NNF,NNI,NNA,IRST,IWST
    COMMON/XD/LF1,LF2,NPAIRS,IVAR(10),IUN(10),ICT(10)
    DIMENSION LABL(4)
    CALL ERTRAN(6,'@ASG,T  2.,F//POS/6  . ')
    MSGR=0
    MSGW=0
    L1=LF1-1
    L2=LF2-1
    I1=IBGCY-L1-L2                             @STARTING CYCLE
    I2=IBGCY+(IPTS-1)*ITV+L1+L2                @ENDING CYCLE
    I3=(I2-I1+1)                         @TOTAL NUMBER OF CYCLES
    IF(I1.GT.0) GO TO 20
    WRITE(6,5)I1
  5 FORMAT(5X,'ERROR IN BREAK ROUTINE, STARTING INDEX IS ',I5)
    STOP
 20 CONTINUE
    DO 30 I=1,NPAIRS
    IJ=IUN(I)
    ICT(I)=I3
    ENCODE(24,25,LABL) IJ
 25 FORMAT('@ASG,UP  ',I2,'.,F//POS/6 . ')
    CALL ERTRAN(6,LABL)
    REWIND IJ
 30 CONTINUE
    DO 60 I=IBGN,IEND
    CALL ZREAD(4,IF,I)
    IF(IF.NE.0) GO TO 75
    KR1=LR*(NR-1)                              @LAST INDEX FOR THIS SEGMENT
    DO 50 IZ=1,NPAIRS                          @LOOP FOR EACH VARIABLE
    IK=IUN(IZ)
    IC=ICT(IZ)
    IJ=IVAR(IZ)
    IF(I.NE.IBGN) GO TO 35
    NVAR=IPR(IJ)
    AB=FDOCR(2)
    AC=FDOCR(1)
    FDOCR(2)=AB+(1./1440.)*(IBGCY-1)*AC
    FDOCR(1)=AC*FLOAT(ITV)
    WRITE(IK,37) (ADOCR(J),J=1,40)
```

GET (CONT'D.)

```
      WRITE(IK,38)  (FDOCR(J),J=1,7)
      WRITE(IK,39)  IPTS,NVAR,NMFR,NMBR
   36 FORMAT(F10.5)
   37 FORMAT(1X,10A6)
   38 FORMAT(7F9.4)
   39 FORMAT(I5,3A6)
      FDOCR(2)=AB
      FDOCR(1)=AC
   35 CONTINUE
      K1=(I1-1)*LR+IJ
      K2=KR1+IJ
      IF(K1.LE.K2)  GO TO 40
      I1=I1-NR
      GO TO 60
   40 CONTINUE
      DO 45 II=K1,K2,LR
      WRITE(IK,36)  VR(II)
      IC=IC-1
      ICT(IZ)=IC
      IF(IC.EQ.0)  GO TO 50
   45 CONTINUE
   50 IF(ICT(NPAIRS).EQ.0)  GO TO 65
      I1=1
   60 CONTINUE
   65 CONTINUE
      DO 70 I=1,NPAIRS
      IJ=IUN(I)
      ENDFILE IJ
      REWIND IJ
   70 CONTINUE
      GO TO 85
   75 WRITE(6,80)  IF
   80 FORMAT(5X,'ERROR IN ZREAD, IF = ',I5)
   85 CONTINUE
      RETURN
      SUBROUTINE ZREAD(IU,IF,IBL)
C
C  THIS SUBROUTINE IS THE READ HALF OF A NON-FORMATTED
C  INPUT-OUTPUT PACKAGE. A COPY OF THE DOCUMENTATION CAN
C  BE OBTAINED FROM Z. R. HALLOCK, X4220.
C
      COMMON / RHDR / LR,NR,NBR,NMBR,NMFR,NFR,NIR,NAR,IPR(1)
      COMMON /RDOCF/FDOCR(1) /RDOCI/IDOCR(1) /RDOCA/ADOCR(1)
      COMMON / RDATA / VR(1)
C
      COMMON / DIAGS / MSGR,MSGW,NNNR,NNNW,NNIP,NNF,NNI,NNA,IRST,IWST
      COMMON / JPOS / JUNIT(30)
      DIMENSION IUNIT(30)
      LOGICAL B1,B210,B10,B35,B45,B69
      DATA MSGR / 2 /
      DATA LLSW/1/, IRST/1/
C
```

GET (CONT'D.)

```
      B1=MSGR.EQ.1
      B210=MSGR.GE.2.AND.MSGR.LE.10
      B10=MSGR.EQ.10
      B35=MSGR.EQ.3.OR.MSGR.EQ.5.OR.MSGR.EQ.7.OR.MSGR.EQ.9.OR.MSGR.EQ.10
      B45=MSGR.EQ.4.OR.MSGR.EQ.5.OR.MSGR.GE.8.AND.MSGR.LE.10
      B69=MSGR.GE.6.AND.MSGR.LE.9
C
C
C
      IBLK=IBL
      IPOS=JUNIT(IU)
      IF(IPOS.EQ.0) IPOS=1
      IF(IBL.EQ.0) IBLK=IUNIT(IU)
      IF(IBLK.LT.IPOS) GO TO 5
    4 IF(IBLK.EQ.IPOS) GO TO 3
C
      READ(IU,END=99,ERR=98)LQ,(XQ,I=1,4),(XQ,J=1,LQ),NFQ,NIQ,NAQ
      IF((NFQ+NIQ+NAQ).EQ.0) GO TO 10
      IF(NFQ.GT.0)READ(IU,END=99,ERR=98)
      IF(NIQ.GT.0)READ(IU,END=99,ERR=98)
      IF(NAQ.GT.0)READ(IU,END=99,ERR=98)
   10 CONTINUE
C1
      READ(IU,END=99,ERR=98)
      IPOS=IPOS+1
      IUNIT(IU)=IPOS
      JUNIT(IU)=IPOS
      GO TO 4
C
    5 IF=0
      REWIND IU
      IF(IBL.EQ.0) IBLK=1
C     IPOS=1
      IUNIT(IU)=IPOS
      JUNIT(IU)=IPOS
      GO TO 4
    3 CONTINUE
C
      READ(IU,END=99,ERR=98)LR,NR,NBR,NMBR,NMFR,(IPR(I),I=1,LR),
     *   NFR,NIR,NAR
      IF(NR.GT.NNNR.OR.LR.GT.NNIP.OR.NFR.GT.NNF.
     *   OR.NIR.GT.NNI.OR.NAR.GT.NNA) GO TO 95
      IF((NFR+NIR+NAR).EQ.0) GO TO 11
      IF(NFR.GT.0)READ(IU,END=99,ERR=98) (FDOCR(I),I=1,NFR)
      IF(NIR.GT.0)READ(IU,END=99,ERR=98) (IDOCR(I),I=1,NIR)
      IF(NAR.GT.0)READ(IU,END=99,ERR=98) (ADOCR(I),I=1,NAR)
   11 CONTINUE
C1
C1
      NL=NR*LR
      N1=(IRST-1)*LR+1
```

GET (CONT'D.)

```
      N2=N1+NL-1
      READ(IU,END=99,ERR=98) (VR(J),J=N1,N2)
C
C
      IPOS=IPOS+1
      IUNIT(IU)=IPOS
      JUNIT(IU)=IPOS
C
      IF(MSGR.EQ.0) GO TO 108
      IF(B210) WRITE(6,1000)IU,NMFR,NBR,NMBR,NR,LR,NFR,NIR,NAR
 1000 FORMAT(' READ UNIT',I3,';  FILE ',A6,
     *   ';  SEGNUM',I4,';  SEGNAM ',A6,';  N=',I6,
     *   ';  L=',I4,'  NF=',I4,'  NI=',I4,'  NA=',I4)
C
      IF(B1) WRITE(6,1011) IU,NMFR,NBR,NMBR,NR,LR,NFR,NIR,NAR
 1011 FORMAT(' RD ',I4,2X,A6,2X,I4,2X,A6,2X,I6,4I4)
C
      IF(B35) WRITE(6,1012)(IPR(I),I=1,LR)
 1012 FORMAT(' PARAMETERS: '12(2X,A6)/(13X,12(2X,A6)))
C
      IF(.NOT.B45) GO TO 110
      IF((NFR+NIR+NAR).EQ.0) GO TO 110
      WRITE(6,1013)
 1013 FORMAT(' ADDL DATA:')
      IF(NFR.GT.0)WRITE(6,1100) (FDOCR(I),I=1,NFR)
      IF(NIR.GT.0)WRITE(6,1101) (IDOCR(I),I=1,NIR)
      IF(NAR.GT.0)WRITE(6,1102) (ADOCR(I),I=1,NAR)
 1100 FORMAT(10G11.5)
 1101 FORMAT(1X,12I6)
 1102 FORMAT(1X,12(A6))
C
  110 IF(.NOT.B69) GO TO 107
      JL=IRST*LR
      J1=JL-LR+1
      WRITE(6,1014) (VR(I),I=J1,JL)
      JL=(NR+IRST-1)*LR
      J1=JL+1-LR
      WRITE(6,1015) (VR(J),J=J1,JL)
 1014 FORMAT(' FIRST CYCLE:',10G11.5/(13X,10G11.5))
 1015 FORMAT(' LAST CYCLE: ',10G11.5/(13X,10G11.5))
C
  107 IF(.NOT.B10) GO TO 108
      WRITE(6,1017)
      IQ1=IRST
      IQ2=IQ1+NR-1
      DO 106 I=IQ1,IQ2
      JL=I*LR
      J1=JL+1-LR
      WRITE(6,1016) I,(VR(J),J=J1,JL)
  106 CONTINUE
 1016 FORMAT(5X,I5,3X,10G11.5/(13X,10G11.5))
```

GET (CONT'D.)

```
 1017 FORMAT(/// LISTING OF DATA'////)
C
  108 IF=0
      IUP=IU
      RETURN
C
C
   95 IF=5
      WRITE(6,1005)NNNR,NNIP,NNF,NNI,NNA,
     *   NR,LR,NFR,NIR,NAR
 1005 FORMAT(/// A DIMENSION IS TOO SMALL.'///
     *   ' NNNR=',I6,'    NNIP=',I6,'    NNF=',I6,
     *   '    NNI=',I6,'    NNA=',I6/// NR=',I6,
     *   '    LR=',I6,'    NFR=',I6,'    NIR=',I6,'    NAR=',I6//)
      RETURN
   98 IF=2
      WRITE(6,1002) IU
 1002 FORMAT(' READ ERROR ON UNIT ',I3)
      RETURN
   99 IF=1
      WRITE(6,1001) IU
 1001 FORMAT(' EOF ON UNIT ',I3)
      RETURN
      SUBROUTINE FILTER(ITV,IFILT,IBGCY)
      COMMON/RDOCA/ADOCR(1)
      COMMON/RDOCF/FDOCR(1)
      COMMON/RHDR/LR
      COMMON/XD/LF1,LF2,NPAIRS,IVAR(10),IUN(10)
      COMMON/FILL/FILT(201),FILT1(201),SER(201)
      REWIND 2
      LF=201
      L1=200
      DO 100 I=1,NPAIRS
      IJ=IUN(I)
      IF(ITV.EQ.1) GO TO 45
      READ(IJ,12)  (ADOCR(J),J=1,40)
      READ(IJ,13)  (FDOCR(J),J=1,7)
      READ(IJ,11)  NPTS,NVAR,NMFR,NMBR
      WRITE(2,12)  (ADOCR(J),J=1,40)
      WRITE(2,13)  (FDOCR(J),J=1,7)
      WRITE(2,11)  NPTS,NVAR,NMFR,NMBR
   11 FORMAT(I5,3A6)
   12 FORMAT(1X,10A6)
   13 FORMAT(7F9.4)
      READ(IJ,14)  (SER(J),J=1,LF)
   14 FORMAT(F10.4)
   15 CONTINUE
      SUM=0.
      DO 20 J=1,LF
   20 SUM=SUM+(SER(J)*FILT(J))
   21 FORMAT(3A6)
```

GET (CONT'D.)

```
      WRITE(2,14) SUM
      DO 25 J=1,L1
   25 SER(J)=SER(J+1)
      READ(IJ,14,END=30) SER(LF)
      GO TO 15
   30 ENDFILE 2
      REWIND 2
      REWIND IJ
      READ(2,12) (ADOCR(J),J=1,40)
      READ(2,13) (FDOCR(J),J=1,7)
      READ(2,11) NPTS,NVAR,NMFR,NMBR
      WRITE(IJ,12) (ADOCR(J),J=1,40)
      WRITE(IJ,13) (FDOCR(J),J=1,7)
      WRITE(IJ,11) NPTS,NVAR,NMFR,NMBR
   35 CONTINUE
      READ(2,14,END=40) X
      WRITE(IJ,14) X
      GO TO 35
   40 ENDFILE IJ
      REWIND 2
      REWIND IJ
   45 CONTINUE
      IF(IFILT.EQ.0) GO TO 70
      READ(IJ,12) (ADOCR(J),J=1,40)
      READ(IJ,13) (FDOCR(J),J=1,7)
      READ(IJ,11) NPTS,NVAR,NMFR,NMBR
      WRITE(2,12) (ADOCR(J),J=1,40)
      WRITE(2,13) (FDOCR(J),J=1,7)
      WRITE(2,11) NPTS,NVAR,NMFR,NMBR
      READ(IJ,14)(SER(J),J=1,LF)
   50 CONTINUE
      SUM=0.
      DO 55 J=1,LF
   55 SUM=SUM+(SER(J)*FILT1(J))
      WRITE(2,14)SUM
      DO 60 J=1,LF
   60 SER(J)=SER(J+1)
      READ(IJ,14,END=65) SER(LF)
      GO TO 50
   65 CONTINUE
      ENDFILE 2
      REWIND IJ
      REWIND 2
   70 CONTINUE
      IR=2
      IF(IFILT.EQ.0) IR=IJ
      IW=IJ
      IF(IFILT.EQ.0) IW=2
      IITV=ITV-1
      READ(IR,12) (ADOCR(J),J=1,40)
      READ(IR,13) (FDOCR(J),J=1,7)
```

GET (CONT'D.)

```
      READ(IR,11) NPTS,NVAR,NMFR,NMBR
      WRITE(IW,12) (ADOCR(J),J=1,40)
      WRITE(IW,13) (FDOCR(J),J=1,7)
      WRITE(IW,11) NPTS,NVAR,NMFR,NMBR
   75 CONTINUE
      IITV=IITV+1
      READ(IR,14,END=80) X
      IKZ=MOD(IITV,ITV)
      IF(IKZ.EQ.0) WRITE(IW,14) X
      GO TO 75
   80 CONTINUE
      ENDFILE IW
      REWIND IW
      REWIND IR
      IF(IW.NE.2) GO TO 95
      READ(IW,12) (ADOCR(J),J=1,40)
      READ(IW,13) (FDOCR(J),J=1,7)
      READ(IW,11) NPTS,NVAR,NMFR,NMBR
      WRITE(IR,12) (ADOCR(J),J=1,40)
      WRITE(IR,13) (FDOCR(J),J=1,7)
      WRITE(IR,11) NPTS,NVAR,NMFR,NMBR
   85 CONTINUE
      READ(IW,14,END=90) X
      WRITE(IR,14) X
      GO TO 85
   90 ENDFILE IR
      REWIND IR
      REWIND IW
   95 CONTINUE
      WRITE(6,105) NVAR,IJ
  105 FORMAT(5X,A6,' ASSIGNED TO UNIT ',I2)
  100 CONTINUE
      RETURN
      SUBROUTINE DETRND
      COMMON/RDOCA/ADOCR(1)
      COMMON/RDOCF/FDOCR(1)
      COMMON/XD/LF1,LF2,NPAIRS,IVAR(10),IUN(10)
      WRITE(6,5)
    5 FORMAT(5X,'INTO SUBROUTINE DETRND')
      DO 50 J=1,NPAIRS
      IU=IUN(J)
      REWIND 2
      REWIND IU
      IFG=1
    8 CONTINUE
      READ(IU,10) (ADOCR(I),I=1,40)
      READ(IU,11) (FDOCR(K),K=1,7)
      READ(IU,12) NPTS,NVAR,NMFR,NMBR
   10 FORMAT(1X,10A6)
   11 FORMAT(7F9.4)
   12 FORMAT(I5,3A6)
```

GET (CONT'D.)

```
 13 FORMAT(F10.5)
    GO TO (15,30,60),IFG
 15 S1=0.
    S2=0.
    K=1.
 20 READ(IU,13,END=25) X
    S1=S1+X
    S2=S2+X*FLOAT(K)
    K=K+1
    GO TO 20
 25 CONTINUE
    REWIND IU
    IFG=2
    GO TO 8
 30 CONTINUE
    A1=(NPTS+1)
    A2=NPTS*(NPTS-1)
    H=FDOCR(1)
    T=0.
    B0=((2.*(2.*NPTS+1)*S1)-6.*S2)/A2
    B1=((12.*S2)-6.*A1*S1)/(H*A2*(NPTS+1))
 35 CONTINUE
    READ(IU,13,END=45) X
    XX=X-(B0+B1*T)
    WRITE(2,13) XX
    T=T+H
    GO TO 35
 45 CONTINUE
    ENDFILE 2
    REWIND 2
    REWIND IU
    IFG=3
    GO TO 8
 60 CONTINUE
    READ(2,13,END=65) X
    WRITE(IU,13)X
    GO TO 60
 65 CONTINUE
    ENDFILE IU
    REWIND IU
    REWIND 2
    WRITE(6,46) NVAR
 46 FORMAT(5X,A6,'   DETRENDED')
 50 CONTINUE
    RETURN
    END
```

II. A. FOURCO

```
C
C  PROGRAM- FOURCO
C  PROGRAMMER- JACK HICKMAN
C  DATE WRITTEN- MARCH,1979
C
C
C      SUBROUTINES REQUIRED
C
C                 PWHITE
C                 WINDOW
C                 FFT
C
C
C      INPUT PARAMETERS
C
C  LTRANS          THE LENGTH OF THE FOURIER TRANSFORM TO APPLY TO THE
C                  TIME SERIES.
C  NUMBER          THE NUMBER OF ESTIMATES TO BE TRANSFORMED.
C  NWINDO          DENOTES THE SPECTRAL WINDOW TO BE APPLIED TO THE TIME
C                  SERIES BEFORE THE FFT IS PERFORMED:
C                     0  BOXCAR(NO) WINDOW
C                     1  10% COSINE WINDOW
C                     2  HANNING WINDOW
C                     3  HAMMING WINDOW
C                     4  PARZEN WINDOW
C                     5  LANCZOS WINDOW.
C  KWHITE          DENOTES IF DATA SHOULD BE PREWHITENED:
C                     0  DO NOT PREWHITEN.
C                     1  PREWHITEN.
C  A               ARRAY CONTAINING THE TIME SERIES ESTIMATES.
C
C
C      VARIABLE LIST
C
C  B               ARRAY FOR THE IMAGINARY FOURIER COEFFICIENTS. FILLED
C                  WITH ZEROES BEFORE THE TRANSFORM IS APPLIED.
C  OUT             FORTRAN UNIT REFERENCE NUMBER FOR THE PRINT DATASET.
C  IN              FORTRAN UNIT REFERENCE NUMBER FOR THE INPUT PARAMETER
C                  DATASET.
C  SUM1            KEEPS A RUNNING SUM OF THE TIME SERIES ESTIMATES TO
C                  USE WHEN CALCULATING THE MEAN.
C  SUM2            KEEPS A RUNNING SUM OF THE SQUARE OF THE TIME SERIES
C                  ESTIMATES TO USE WHEN CALCULATING THE MEAN SQUARED
C                  VALUE.
C  RNUMB           SAME AS NUMBER BUT REAL.
C  YBAR            THE MEAN OF THE INPUT TIME SERIES DATA.
C  YBARSQ          THE MEAN SQUARE VALUE OF THE TIME SERIES DATA.
```

FOURCO (CONT'D.)

```
C  OUTDS           FORTRAN UNIT REFERENCE NUMBER FOR THE FOURIER COEFFI-
C                  CIENT DATASET.
C  IHD,FHD,IVAR,   VARIABLES TO STORE INFORMATION FROM THE FEBFILE HEADER
C  NMFF,NMBF       RECORD.
C  I,J             INDEXES.
C
      DIMENSION IHD(40),FHD(10)
      REAL A(10000),B(10000)
      INTEGER OUT,OUTDS
      COMMON A,B
      IN=5
      OUT=6
C
C  INPUT PARAMETERS AND ECHO CHECK.
C
      READ(IN,10)LTRANS,NWINDO,KWHITE
   10 FORMAT(3I10)
      WRITE(OUT,20)LTRANS,NWINDO,KWHITE
   20 FORMAT('1'//6X,'LTRANS',5X,'NWINDO',4X,'KWHITE'//3I10)
C
C  INPUT TIME SERIES DATA FROM FILE CREATED BY GET PROGRAM
C
      DO 9999 INDS=7,10
      READ(INDS,71) (IHD(I),I=1,40)
   71 FORMAT(1X,10A6)
      WRITE(OUT,71) (IHD(I),I=1,40)
      READ(INDS,72) (FHD(I),I=1,7)
   72 FORMAT(7F9.4)
      WRITE(OUT,72) (FHD(I),I=1,7)
      READ(INDS,73)NUMBER,IVAR,NMFR,NMBR
   73 FORMAT(I5,3A6)
      WRITE(OUT,77)NUMBER,IVAR,NMFR,NMBR
   77 FORMAT(' ',I5,3A6)
      READ(INDS,74) (A(I),I=1,NUMBER)
   74 FORMAT(F10.5)
      REWIND 7
      NFFT=LTRANS/2+1
C
C  DETERMINE MEAN AND MEAN SQUARE OF INPUT TIME SERIES.
C
      SUM1=0.
      SUM2=0.
      DO 102 I=1,NUMBER
         SUM1=SUM1+A(I)
         SUM2=SUM2+A(I)*A(I)
  102    CONTINUE
      RNUMB=FLOAT(NUMBER)
      YBAR=SUM1/RNUMB
      YBARSQ=SUM2/RNUMB-YBAR*YBAR
      WRITE(OUT,13)YBAR,YBARSQ
   13 FORMAT(/// ',3X,'MEAN OF TIME SERIES: ',F12.3///     MEAN SQUARE',
     +         ' OF TIME SERIES: ',F12.3)
```

FOURCO (CONT'D.)

```
C
C  SUBTRACT MEAN FROM DATA VALUES.
C
      DO 103 I=1,NUMBER
         A(I)=A(I)-YBAR
  103    CONTINUE
C
C  CALL SUBROUTINE PWHITE TO PREWHITEN DATA IF USER DESIRES.
C
      IF(KWHITE.GT.0)CALL PWHITE(NUMBER)
C
C  CALL SUBROUTINE WINDOW TO WINDOW THE DATA IN THE TIME DOMAIN.
C
      CALL WINDOW(NWINDO,NUMBER)
C
C  ADD ZEROES TO FILL REMAINDER OF REAL ARRAY TO THE TRANSFORM LENGTH.
C  ALSO FILL IMAGINARY ARRAY B WITH ZEROES.
C
      J=NUMBER+1
      DO 104 I=J,LTRANS
         A(I)=0.
  104    CONTINUE
      DO 105 I=1,LTRANS
         B(I)=0.
  105    CONTINUE
C
C  CALL FFT TO DO FAST FOURIER TRANSFORM. MAKE ISN PARAMETER NEGATIVE
C  SO COMPLEX NUMBERS WILL HAVE THE FORM A-BI.
C
      CALL FFT(A,B,LTRANS,LTRANS,LTRANS,-1)
      OUTDS=INDS+10
      WRITE(OUTDS,75)LTRANS,NUMBER,NWINDO
   75 FORMAT(2I5,I1)
      WRITE(OUTDS,76) (A(I),B(I),I=1,NFFT)
   76 FORMAT(2A6)
 9999 CONTINUE
      STOP
      END
```

II. B.1 FFT

```
      SUBROUTINE FFT(A,B,NTOT,N,NSPAN,ISN)
C
C MULTIVARIATE COMPLEX FOURIER TRANSFORM, COMPUTD IN PLACE
C    BY USING MIXED RADIX FAST FOURIER TRANSFORM ALGORITHM.
C BY R. C. SINGLETON, STANFORD RESEARCH INSTITUTE, OCT. 1968
C    IEEE TRANS. AU., JUNE 1969.
C ARRAYS A AND B ORIGINALLY HOLD THE REAL AND IMAGINARY
C    COMPONENTS OF THE DATA, AND RETURN THE REAL AND IMAGINARY
C    COMPONENTS OF THE RESULTING FOURIER COEFFICIENTS.
C MULTIVARIATE DATA IS INDEXED ACCORDING TO THE FORTRAN
C    ARRAY ELEMENT SUCCESSOR FUNCTION.  WITHOUT LIMIT
C    ON THE NUMBER OF IMPLIED MULTIPLE SUBSCRIPTS.
C    THE SUBROUTINE IS CALLED ONCE FOR EACH VARIATE.
C    THE CALLS FOR A MULTIPLE VARIATE TRANSFORM MAY BE IN ANY ORDER.
C NTOT IS THE TOTAL NUMBER OF COMPLEX DATA VALUES.
C N IS THE DIMENSION OF THE CURRENT VARIABLE.
C NSPAN/N IS THE SPACINGOF TE CONSECUTIVE DATA VALUES
C           WHILE INDEXING THE CURRENT VARIABLE.
C THE SIGN OF ISN DETERMINES THE SIGN OF THE COMPLEX
C    EXPONENTIAL, AND THE MAGNITUDE OF ISN IS NORMALLY ONE.
C A TRI-VARIATE TRANSFORM WITH A(N1,N2,N3), B(N1,N2,N3) IS
C    COMPUTED BY:
C     CALL FFT(A,B,N1*N2*N3,N1,N1,1)
C     CALL FFT(A,B,N1*N2*N3,N2,N1*N2,1)
C     CALL FFT(A,B,N1*N2*N3,N3,N1*N2*N3,1)
C
C FOR A SINGLE-VARIATE TRANSFORM,
C    NTOT = N = NSPAN = (NUMBER OF COMPLEX DATA VALUES), E.G.,
C
C     CALL FFT (A,B,N,N,N,1)
C
C THE DATA MAY ALTERNATELY BE STORED IN A SIGLE COMPLES ARRAY A,
C    THEN THE MAGNITUDE OF ISN IS CHANGED TO TWO TO GIVE
C    THE CORRECT INDEXING INCREMENT, AND A(2) USED TO PASS
C    THE INITIAL ADDRESS FOR THE SEQUENCE OF IMAGINARY VALUES.  E.G.,
C
C
C     CALL FFT (A,A(2),NTOT,N,NSPAN,2)
C
C ARRAYS AT(MAXF), BT(MAXF), CK(MAXF), SK(MAXF), AND NP(MAXP)
C   ARE USED FOR TEMPORARY STORAGE.  IF TE THE AVAILABLE STORAGE IS
C   INSUFFICIENT,  THE PROGRAMIS TERMINATED BY A STOP AND ISN=0.
C   MAXF MUST BE .GE. THE MAXIMUM PRIME FACTOR OF N.
C   MAXP MUST BE .GT. THE NUMBER OF PRIME FACTORS OF  N.
C   IN ADDITION, IF THE SQUARE-FREE PORTION, K, OF N HAS TWO OR MORE
C   PRIME FACTORS, THEN MAXP MUST BE .GE. K-1
C
C     <><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>
C
```

FFT (CONT'D.)

```
      COMPLEX CMPLX
      DIMENSION A(10000),B(10000)
C ARRAY STORAGE IN NFAC FOR A MAXIMUM OF 11 FACTORS OF N.
C FREE FACTORS MUST BE .LE. 210.
      DIMENSION NFAC(11), NP(209)
C ARRAY STORAGE FOR MAXIMUM PRIME FACTOR OF 23
      DIMENSION AT(23), CK(23), BT(23), SK(23)
      EQUIVALENCE (I,II)
C THE FOLLOWING TWO CONSTANTS SHOULD AGREE WITH THE ARRAY DIMENSIONS.
      MAXF=23
      MAXP=209
      IF (N .LT. 2) RETURN
      INC=ISN
      RAD=8.0*ATAN(1.0)
      S72=RAD/5.0
      C72=COS(S72)
      S72=SIN(S72)
      S120=SQRT(0.75)
      IF (ISN .GE. 0) GO TO 10
      S72=-S72
      S120=-S120
      RAD=-RAD
      INC=-INC
10    NT=INC*NTOT
      KS=INC*NSPAN
      KSPAN=KS
      NN=NT-INC
      JC=KS/N
      RADF=RAD*FLOAT(JC)*0.5
      I=0
      JF=0
C DETERMINE FACTORS OF N
      M=0
      K=N
      GO TO 20
15    M=M+1
      NFAC(M)=4
      K=K/16
20    IF (K-(K/16)*16 .EQ. 0) GO TO 15
      J=3
      JJ=9
      GO TO 30
25    M=M+1
      NFAC(M)=J
      K=K/JJ
30    IF (MOD(K,JJ) .EQ. 0) GO TO 25
      J=J+2
      JJ=J*J
      IF (JJ .LE. K) GO TO 30
      IF (K .GT. 4) GO TO 40
      KT=M
      NFAC(M+1)=K
```

FFT (CONT'D.)

```
      IF (K .NE. 1) M=M+1
      GO TO 80
 40   IF (K-(K/4)*4 .NE. 0) GO TO 50
      M=M+1
      NFAC(M)=2
      K=K/4
 50   KT=M
      J=2
 60   IF (MOD(K,J) .NE. 0) GO TO 70
      M=M+1
      NFAC(M)=J
      K=K/J
 70   J=((J+1)/2)*2+1
      IF (J.LE. K) GO TO 60
 80   IF (KT .EQ. 0) GO TO 100
      J=KT
 90   M=M+1
      NFAC(M)=NFAC(J)
      J=J-1
      IF (J .NE. 0) GO TO 90
C
C END 000 BLOCK
C COMPUTE THE FOURIER TRANSFORM.
C
 100  SD=RADF/FLOAT(KSPAN)
      CD=2.0*SIN(SD)**2
      SD=SIN(SD+SD)
      KK=1
      I=I+1
      IF (NFAC(I) .NE. 2) GO TO 400
C
C TRANSFORM FOR FACTOR OF 2 (INCLUDES ROTATION FACTOR).
C
      KSPAN=KSPAN/2
      K1=KSPAN+2
 210  K2=KK+KSPAN
      AK=A(K2)
      BK=B(K2)
      A(K2)=A(KK)-AK
      B(K2)=B(KK)-BK
      A(KK)=A(KK)+AK
      B(KK)=B(KK)+BK
      KK=K2+KSPAN
      IF (KK .LE. NN) GO TO 210
      KK=KK-NN
      IF (KK .LE. JC) GO TO 210
      IF (KK .GT. KSPAN) GO TO 800
 220  C1=1.0-CD
      S1=SD
 230  K2=KK+KSPAN
      AK=A(KK)-A(K2)
      BK=B(KK)-B(K2)
```

FFT (CONT'D.)

```
      A(KK)=A(KK)+A(K2)
      B(KK)=B(KK)+B(K2)
      A(K2)=C1*AK-S1*BK
      B(K2)=S1*AK+C1*BK
      KK=K2+KSPAN
      IF(KK .LT. NT) GO TO 230
      K2=KK-NT
      C1=-C1
      KK=K1-K2
      IF (KK .GT. K2) GO TO 230
      AK=C1-(CD*C1+SD*S1)
      S1=S1+(SD*C1-CD*S1)
C
C THE FOLLOWING THREE STATEMENTS COMPENSATE FOR TRUNCATION ERROR.
C    IF ROUNDED ARITHMETIC IS USED, SUBSTITUE:
C     C1=AK
C
      C1=0.5/(AK*AK+S1*S1)+0.5
      S1=C1*S1
      C1=C1*AK
      KK=KK+JC
      IF (KK .LT. K2) GO TO 230
      K1=K1+INC+INC
      KK=(K1-KSPAN)/2+JC
      IF (KK .LE. JC+JC) GO TO 220
      GO TO 100
C
C END 200 BLOCK
C TRANSFORM FOR FACTOR OF 3 (OPTIONAL CODE).
C
320   K1=KK+KSPAN
      K2=K1+KSPAN
      AK=A(KK)
      BK=B(KK)
      AJ=A(K1)+A(K2)
      BJ=B(K1)+B(K2)
      A(KK)=AK+AJ
      B(KK)=BK+BJ
      AK=-0.5*AJ+AK
      BK=-0.5*BJ+BK
      AJ=(A(K1)-A(K2))*S120
      BJ=(B(K1)-B(K2))*S120
      A(K1)=AK-BJ
      B(K1)=BK+AJ
      A(K2)=AK+BJ
      B(K2)=BK-AJ
      KK=K2+KSPAN
      IF (KK .LT. NN) GO TO 320
      KK=KK-NN
      IF (KK .LE. KSPAN) GO TO 320
      GO TO 700
```

FFT (CONT'D.)

```
C
C END 300 BLOCK.
C TRANSFORM FOR FACTOR OF FOUR (INCLUDES ROTATION FACTOR)
C
400    IF (NFAC(I) .NE. 4) GO TO 600
       KSPNN=KSPAN
        KSPAN=KSPAN/4
410    C1=1.0
       S1=0.0
420    K1=KK+KSPAN
       K2=K1+KSPAN
       K3=K2+KSPAN
       AKP=A(KK)+A(K2)
       AKM=A(KK)-A(K2)
       AJP=A(K1)+A(K3)
       AJM=A(K1)-A(K3)
       A(KK)=AKP+AJP
       AJP=AKP-AJP
       BKP=B(KK)+B(K2)
       BKM=B(KK)-B(K2)
       BJP=B(K1)+B(K3)
       BJM=B(K1)-B(K3)
       B(KK)=BKP+BJP
       BJP=BKP-BJP
       IF (ISN .LT. 0) GO TO 450
       AKP=AKM-BJM
       AKM=AKM+BJM
       BKP=BKM+AJM
       BKM=BKM-AJM
       IF (S1 .EQ. 0.0) GO TO 460
430       A(K1)=AKP*C1-BKP*S1
       B(K1)=AKP*S1+BKP*C1
       A(K2)=AJP*C2-BJP*S2
       B(K2)=AJP*S2+BJP*C2
       A(K3)=AKM*C3-BKM*S3
       B(K3)=AKM*S3+BKM*C3
       KK=K3+KSPAN
       IF (KK .LE. NT) GO TO 420
440    C2=C1-(CD*C1+SD*S1)
       S1=S1+(SD*C1-CD*S1)
C
C THE FOLLOWING THREE STATEMENTS COMPENSATE FOR TRUNCATION ERROR.
C IF ROUNDED ARITHMETIC IS USED, SUBSTITUTE:
C      C1=C2
C
       C1=0.5/(C2*C2+S1*S1)+0.5
       S1=C1*S1
       C1=C1*C2
       C2=C1*C1-S1*S1
       S2=2.0*C1*S1
       C3=C2*C1-S2*S1
       S3=C2*S1+S2*C1
```

FFT (CONT'D.)

```
      KK=KK-NT+JC
      IF (KK .LE. KSPAN) GOTO 420
      KK=KK-KSPAN+INC
      IF (KK .LE. JC) GO TO 410
      IF (KSPAN .EQ. JC) GO TO 800
      GO TO 100
 450  AKP=AKM+BJM
      AKM=AKM-BJM
      BKP=BKM-AJM
      BKM=BKM+AJM
      IF (S1 .NE. 0.0) GO TO 430
 460  A(K1)=AKP
      B(K1)=BKP
      A(K2)=AJP
      B(K2)=BJP
      A(K3)=AKM
      B(K3)=BKM
      KK=K3+KSPAN
      IF (KK .LE. NT) GO TO 420
      GO TO 440
C
C END 400 BLOCK
C TRANSFORM FOR FACTOR OF FIVE (OPTIONAL CODE).
C
 510  C2=C72*C72-S72*S72
      S2=2.0*C72*S72
 520  K1=KK+KSPAN
      K2=K1+KSPAN
      K3=K2+KSPAN
      K4=K3+KSPAN
      AKP=A(K1)+A(K4)
      AKM=A(K1)-A(K4)
      BKP=B(K1)+B(K4)
      BKM=B(K1)-B(K4)
      AJP=A(K2)+A(K3)
      AJM=A(K2)-A(K3)
      BJP=B(K2)+B(K3)
      BJM=B(K2)-B(K3)
      AA=A(KK)
      BB=B(KK)
      A(KK)=AA+AKP+AJP
      B(KK)=BB+BKP+BJP
      AK=AKP*C72+AJP*C2+AA
      BK=BKP*C72+BJP*C2+BB
      AJ=AKM*S72+AJM*S2
      BJ=BKM*S72+BJM*S2
      A(K1)=AK-BJ
      A(K4)=AK+BJ
      B(K1)=BK+AJ
      B(K4)=BK-AJ
      AK=AKP*C2+AJP*C72+AA
      BK=BKP*C2+BJP*C72+BB
```

FFT (CONT'D.)

```
      AJ=AKM*S2-AJM*S72
      BJ=BKM*S2-BJM*S72
      A(K2)=AK-BJ
      A(K3)=AK+BJ
      B(K2)=BK+AJ
      B(K3)=BK-AJ
      KK=K4+KSPAN
      IF (KK .LT. NN) GO TO 520
      KK=KK-NN
      IF (KK .LE. KSPAN) GO TO 520
      GO TO 700
C
C
C END 500 BLOCK
C TRANSFORM FOR ODD FACTORS.
C
600   K=NFAC(I)
      KSPNN=KSPAN
      KSPAN=KSPAN/K
      IF (K .EQ. 3) GO TO 320
      IF (K .EQ. 5) GO TO 510
      IF (K .EQ. JF) GO TO 640
      JF=K
      S1=RAD/FLOAT(K)
      C1=COS(S1)
      S1=SIN(S1)
      IF (JF .GT.MAXF) GO TO 998
      CK(JF)=1.0
      SK(JF)=0.0
      J=1
630   CK(J)=CK(K)*C1+SK(K)*S1
      SK(J)=CK(K)*S1-SK(K)*C1
      K=K-1
      CK(K)=CK(J)
      SK(K)=-SK(J)
      J=J+1
      IF (J .LT. K) GO TO 630
640   K1=KK
      K2=KK+KSPNN
      AA=A(KK)
      BB=B(KK)
      AK=AA
      BK=BB
      J=1
      K1=K1+KSPAN
650   K2=K2-KSPAN
      J=J+1
      AT(J)=A(K1)+A(K2)
      AK=AT(J)+AK
      BT(J)=B(K1)+B(K2)
      BK=BT(J)+BK
      J=J+1
```

FFT (CONT'D.)

```
      AT(J)=A(K1)-A(K2)
      BT(J)=B(K1)-B(K2)
      K1=K1+KSPAN
      IF (K1 .LT. K2) GO TO 650
      A(KK)=AK
      B(KK)=BK
      K1=KK
      K2=KK+KSPNN
      J=1
660   K1=K1+KSPAN
      K2=K2-KSPAN
      JJ=J
      AK=AA
      BK=BB
      AJ=0.0
      BJ=0.0
      K=1
670   K=K+1
      AK=AT(K)*CK(JJ)+AK
      BK=BT(K)*CK(JJ)+BK
      K=K+1
      AJ=AT(K)*SK(JJ)+AJ
      BJ=BT(K)*SK(JJ)+BJ
      JJ=JJ+J
      IF (JJ .GT. JF) JJ=JJ-JF
      IF (K .LT. JF) GO TO 670
      K=JF-J
      A(K1)=AK-BJ
      B(K1)=BK+AJ
      A(K2)=AK+BJ
      B(K2)=BK-AJ
      J=J+1
      IF (J .LT. K) GO TO 660
      KK=KK+KSPNN
      IF (KK .LE. NN) GO TO 640
      KK=KK-NN
      IF (KK .LE. KSPAN) GO TO 640
C
C END 600 BLOCK
C MULTIPLY BY ROTATION FACTORS (EXCEPT FOR FACTORS OF 2 AND 4)
C
700   IF (I .EQ. M) GO TO 800
      KK=JC+1
710   C2=1.0-CD
      S1=SD
720   C1=C2
      S2=S1
      KK=KK+KSPAN
730   AK=A(KK)
      A(KK)=C2*AK-S2*B(KK)
      B(KK)=S2*AK+C2*B(KK)
      KK=KK+KSPNN
      IF (KK .LE. NT) GO TO 730
      AK=S1*S2
      S2=S1*C2+C1*S2
      C2=C1*C2-AK
      KK=KK-NT+KSPAN
      IF(KK .LE. KSPNN) GO TO 730
      C2=C1-(CD*C1+SD*S1)
      S1=S1+(SD*C1-CD*S1)
C
C THE FOLLOWING THREE STATEMENTS COMPENSATE FOR TRUNCATION ERROR.
C    IF ROUNDED ARITMETIC IS USED, THEY MAY BE DELETED.
C
      C1=0.5/(C2*C2+S1*S1)+0.5
      S1=S1*C1
      C2=C1*C2
      KK=KK-KSPNN+JC
      IF (KK .LE. KSPAN) GO TO 720
      KK=KK-KSPAN+JC+INC
      IF (KK .LE. JC+JC) GO TO 710
      GO TO 100
C
C END 700 BLOCK
C PERMUTE THE RESULTS TO NORMAL ORDER. THIS IS DONE IN TWO STAGES.
C PERMUTATION FOR SQUARE FACTORS OF N
C
800   NP(1)=KS
      IF (KT .EQ. 0) GO TO 890
      K=KT+KT+1
      IF (M .LT. K) K=K-1
      J=1
      NP(K+1)=JC
810   NP(J+1)=NP(J)/NFAC(J)
      NP(K)=NP(K+1)*NFAC(J)
      J=J+1
      K=K-1
      IF (J .LT. K) GO TO 810
      K3=NP(K+1)
      KSPAN=NP(2)
      KK=JC+1
      K2=KSPAN+1
      J=1
      IF (N .NE. NTOT). GO TO 850
C
C PERMUTATION FOR SINGLE-VARIATE TRANSFORM (OPTIONAL CODE).
C
820   AK=A(KK)
      A(KK)=A(K2)
      A(K2)=AK
      BK=B(KK)
      B(KK)=B(K2)
      B(K2)=BK
      KK=KK+INC
```

FFT (CONT'D.)

```
      K2=KSPAN+K2
      IF (K2 .LT. KS) GO TO 820
830   K2=K2-NP(J)
      J=J+1
      K2=NP(J+1)+K2
      IF(K2 .GT. NP(J)) GO TO 830
      J=1
840   IF(KK .LT. K2) GO TO 820
      KK=KK+INC
      K2=KSPAN+K2
      IF (K2 .LT. KS) GO TO 840
      IF (KK .LT. KS) GO TO 830
      JC=K3
      GO TO 890
C
C PERMUTE FOR MULTIVATRIATE TRANSFORM.
C
850   K=KK+JC
860   AK=A(KK)
      A(KK)=A(K2)
      A(K2)=AK
      BK=B(KK)
      B(KK)=B(K2)
      B(K2)=BK
      KK=KK+INC
       T
      K2=K2+INC
      IF (KK .LT. K) GO TO 860
      KK=KK+KS-JC
      K2=K2+KS-JC
      IF (KK .LT. NT) GO TO 850
      K2=K2-NT+KSPAN
      KK=KK-NT+JC
      IF (K2 .LT. KS) GO TO 850
870   K2=K2-NP(J)
      J=J+1
      K2=NP(J+1)+K2
      IF (K2 .GT. NP(J)) GO TO 870
      J=1
880   IF (KK .LT. K2) GO TO 850
      KK=KK+JC
      K2=KSPAN+K2
      IF (K2 .LT. KS) GO TO 880
      IF (KK .LT. KS) GO TO 870
      JC=K3
890   IF (2*KT+1 .GE. M) RETURN
      KSPNN=NP(KT+1)
C
C END 800 BLOCK
C PERMUTATION FOR SQUARE FREE FACTORS OF N.
C
      J=M-KT
```

FFT (CONT'D.)

```
      NFAC(J+1)=1
 900  NFAC(J)=NFAC(J)*NFAC(J+1)
      J=J-1
      IF (J .NE. KT) GO TO 900
      KT=KT+1
      NN=NFAC(KT)-1
      IF (NN .GT. MAXP) GO TO 998
      JJ=0
      J=0
      GO TO 906
 902  JJ=JJ-K2
      K2=KK
      K=K+1
      KK=NFAC(K)
 904  JJ=KK+JJ
      IF (JJ .GE. K2) GO TO 902
      NP(J)=JJ
 906  K2=NFAC(KT)
      K=KT+1
      KK=NFAC(K)
      J=J+1
      IF (J .LE. NN) GO TO 904
C
C DETERMINE PERMUATION CYCLES OF LENGTH GREATER THAN 1.
C
      J=0
      GO TO 914
 910  K=KK
      KK=NP(K)
      NP(K)=-KK
      IF (KK .NE. J) GO TO 910
      K3=KK
 914  J=J+1
      KK=NP(J)
      IF (KK .LT. 0) GO TO 914
      IF (KK .NE. J) GO TO 910
      NP(J)=-J
      IF(J .NE. NN) GO TO 914
      MAXF=INC*MAXF
C
C REORDER A AND B, FOLLOWING THE PERMUTATION CYCLES.
C
      GO TO 950
 924  J=J-1
      IF (NP(J) .LT. 0) GO TO 924
      JJ=JC
 926  KSPAN=JJ
      IF (JJ .GT. MAXF) KSPAN=MAXF
      JJ=JJ-KSPAN
      K=NP(J)
      KK=JC*K+II+JJ
      K1=KK+KSPAN
```

FFT (CONT'D.)

```
      K2=0
 928  K2=K2+1
      AT(K2)=A(K1)
      BT(K2)=B(K1)
      K1=K1-INC
      IF (K1 .NE.KK) GO TO 928
 932  K1=KK+KSPAN
      K2=K1-JC*(K+NP(K))
      K=-NP(K)
 936  A(K1)=A(K2)
      B(K1)=B(K2)
      K1=K1-INC
      K2=K2-INC
      IF (K1 .NE. KK) GO TO 936
      KK=K2
      IF (K .NE. J) GO TO 932
      K1=KK+KSPAN
      K2=0
 940  K2=K2+1
      A(K1)=AT(K2)
      B(K1)=BT(K2)
      K1=K1-INC
      IF (K1 .NE. KK) GO TO 940
      IF (JJ .NE. 0) GO TO 926
      IF (J .NE. 1) GO TO 924
 950  J=K3+1
      NT=NT-KSPNN
      II=NT-INC+1
      IF (NT .GE. 0) GO TO 924
      RETURN
C
C ERROR FINISH. INSUFFICIENT ARRAY STORAGE, TOO LARGE A FACTOR.
C
 998  ISN=0
      WRITE(6,999)
 999  FORMAT('  ARRAY BOUNDS EXCEDED WITHIN SUBOUTINE FFT.' )
      STOP
      END
```

II. B.2 PWHITE

```
      SUBROUTINE PWHITE(NUMBER)
C
C  THIS SUBROUTINE PREWHITENS TIME SERIES DATA WITH A FIRST ORDER DIF-
C  FERENCE FILTER. NOTE THAT THE LAST VALUE IS SET EQUAL TO THE VALUE
C  PRECEDING IT.
C
C
C       VARIABLE LIST
C
C  A                 ARRAY CONTAINING THE TIME SERIES ESTIMATES.
C  NUMBER            THE NUMBER OF ESTIMATES TO PREWHITEN.
C  I,J               INDEXES.
C
      REAL A(10000)
      COMMON A
      J=NUMBER-1
      DO 10 I=1,J
         A(I)=A(I+1)-A(I)
   10    CONTINUE
      A(NUMBER)=A(NUMBER-1)
      RETURN
      END
```

II. B.3 WINDOW

```
      SUBROUTINE WINDOW(IOPT,NUMBER)
C
C  THIS SUBROUTINE APPLIES A SPECTRAL WINDOW TO THE TIME SERIES DATA.
C
C
C      VARIABLE LIST
C
C  A             ARRAY CONTAINING THE TIME SERIES ESTIMATES.
C  IOPT          DENOTES THE SPECTRAL WINDOW TO APPLY TO THE TIME SERIES
C                DATA:
C                    0  BOXCAR(NO) WINDOW
C                    1  10% COSINE WINDOW
C                    2  HANNING WINDOW
C                    3  HAMMING WINDOW
C                    4  PARZEN WINDOW
C                    5  LANCZOS WINDOW.
C  NUMBER        THE NUMBER OF ESTIMATES TO APPLY THE WINDOW TO.
C  NP1           NUMBER PLUS 1.
C  SCALE         ARRAY OF SCALE FACTORS USED IN THE 10% COSINE WINDOW.
C  FACTOR        MULTIPLICATIVE SCALE FACTOR.
C  TENPCT        TEN PERCENT OF NUMBER.
C  N             POINTER.
C  I,J,K         INDEXES.
C
      REAL A(10000),SCALE(1001)
      INTEGER TENPCT
      COMMON A
      PI=3.141592654
C
C  DETERMINE TYPE OF WINDOW TO USE AND GO TO APPROPRIATE CODE.
C
      N=IOPT+1
      GO TO (100,101,102,103,104,105), N
C
C  BOXCAR(NO) WINDOW.
C
  100 RETURN
C
C  10% COSINE WINDOW.
C
  101 TENPCT=NUMBER/10+1
      FACTOR=10.*PI/(FLOAT(NUMBER)-1.)
      DO 110 I=1,TENPCT
         SCALE(I)=.5*(1.-COS(FACTOR*FLOAT(I-1)))
         A(I)=A(I)*SCALE(I)
  110    CONTINUE
      J=NUMBER-TENPCT
```

WINDOW (CONT'D.)

```
      K=TENPCT+1
      DO 111 I=1,TENPCT
         A(J+I)=A(J+I)*SCALE(K-I)
 111     CONTINUE
      RETURN
C
C  HANNING WINDOW.
C
 102  FACTOR=2.*PI/FLOAT(NUMBER-1)
      DO 120 I=1,NUMBER
         A(I)=A(I)*.5*(1.+COS(FACTOR*FLOAT(I-1)+PI))
 120     CONTINUE
      RETURN
C
C  HAMMING WINDOW.
C
 103  FACTOR=2.*PI/FLOAT(NUMBER-1)
      DO 130 I=1,NUMBER
         A(I)=A(I)*(.54+.46*COS(FACTOR*FLOAT(I-1)+PI))
 130     CONTINUE
      RETURN
C
C  PARZEN WINDOW.
C
 104  J=NUMBER/4
      DO 140 I=1,J
         FACTOR=FLOAT(2*(I-1)-NUMBER+1)/FLOAT(NUMBER-1)
         A(I)=A(I)*2.*(1.-ABS(FACTOR))**3
 140     CONTINUE
      J=J+1
      K=3*NUMBER/4
      DO 141 I=J,K
         FACTOR=FLOAT(2*(I-1)-NUMBER+1)/FLOAT(NUMBER-1)
         A(I)=A(I)*(1.-6.*FACTOR*FACTOR+6.*ABS(FACTOR)*FACTOR*FACTOR)
 141     CONTINUE
      K=K+1
      DO 142 I=K,NUMBER
         FACTOR=FLOAT(2*(I-1)-NUMBER+1)/FLOAT(NUMBER-1)
         A(I)=A(I)*2.*(1.-ABS(FACTOR))**3
 142     CONTINUE
      RETURN
C
C  LANCZOS WINDOW.
C
 105  DO 150 I=1,NUMBER
         B=FLOAT(2*(I-1)-NUMBER+1)/FLOAT(NUMBER-1)
         A(I)=A(I)*SIN(B*PI)/(B*PI)
 150     CONTINUE
      RETURN
      END
```

III. A. RSPEC

```
C
C  PROGRAM- RSPEC
C  PROGRAMMER- JACK HICKMAN
C  DATE WRITTEN- MARCH,1979
C
C
C  THIS PROGRAM PERFORMS A ROTARY SPECTRAL ANALYSIS OF TIME SERIES DATA.
C  INPUT CONSISTS OF TWO FOURIER COEFFICIENT DATASETS(THE U AND V COM-
C  PONENTS),VARIABLES DESCRIBING THE ORIGINAL TIME SERIES,AND VARIOUS
C  USER SPECIFIED PARAMETERS. THESE PARAMETERS ALLOW THE USER TO APPLY A
C  VARIETY OF SCALING AND AVERAGING COMBINATIONS. AVERAGING METHODS IN-
C  CLUDE BLOCK AVERAGING RESULTING IN INDEPENDENT ESTIMATES,CONVOLUTION
C  AVERAGING PRODUCING DEPENDENT ESTIMATES,OR A COMBINATION OF BOTH
C  METHODS. GREAT CARE WAS TAKEN IN THE WRITING OF THIS PROGRAM TO AVOID
C  POTENTIAL CORE REGION PROBLEMS. ALTHOUGH THE ARRAYS CONTAINING THE
C  FOURIER COEFFICIENTS MUST BE SUFFICIENTLY LARGE TO INPUT ALL OF THE
C  INPUT DATA, THE 'G' ARRAYS,WHICH CONTAIN THE VALUES THAT ARE
C  AVERAGED AND THEN USED IN THE CALCULATION OF THE OUTPUT DATA,ARE OF
C  VARIABLE LENGTH. THE USER MAY ALTER THE SIZES OF THESE ARRAYS TO SUIT
C  HIS OR HER DATA AND MACHINE. NATURALLY,THE SMALLER THE ARRAYS ARE,
C  THE MORE SWAPPING IS REQUIRED RESULTING IN GREATER EXECUTION TIMES.
C  THE ONLY RESTRICTION IS THAT THE 'G' ARRAYS MUST BE GREATER THAN
C  DOUBLE THE LARGEST NN VALUE USED. THE VALUE OF THE VARIABLE 'IASIZE'
C  MUST BE ALTERED TO REFLECT THE SIZE OF THE 'G' ARRAYS.
C
C
C      SUBROUTINES REQUIRED
C
C                AVRG
C                BAVRG
C                SL
C                CALC
C                CONINT
C                STAT
C
C
C      INPUT PARAMETERS
C
C  LTRANS        THE SIZE OF THE FOURIER TRANSFORM APPLIED TO THE TIME
C                SERIES DATA.
C  STEP          THE TIME INCREMENT(IN HOURS) BETWEEN THE TIME SERIES
C                ESTIMATES.
C  LENGTH        THE NUMBER OF ESTIMATES IN THE TIME SERIES.
C  NINPUT        THE NUMBER OF FOURIER COEFFICIENTS INPUT.
C  IOPT          DETERMINES THE TYPE OF AVERAGING TO USE:
C                     1  BLOCK AVERAGING.
C                     2  CONVOLUTION AVERAGING.
C                     3  COMBINATION OF BLOCK AND CONVOLUTION AVERAGING.
```

RSPEC (CONT'D.)

```
C  NN              THE NUMBER OF ADJACENT FREQUENCY BANDS TO AVERAGE OVER.
C  NUMBNN          THE NUMBER OF NN VALUES TO USE IF BLOCK AVERAGING.
C  NIN1,EIN1       THE FORTRAN UNIT REFERENCE NUMBERS FOR THE FOURIER
C                  COEFFICIENT INPUT DATASETS.
C  NWINDO          DENOTES THE TYPE OF SPECTRAL WINDOW USED WHEN COMPU-
C                  TING FOURIER COEFFICIENTS:
C                      0  BOXCAR(NO) WINDOW.
C                      1  10% COSINE WINDOW.
C                      2  HANNING WINDOW.
C                      3  HAMMING WINDOW.
C                      4  PARZEN WINDOW.
C                      5  LANCZOS WINDOW.
C  IWSOPT          DENOTES WHETHER SPECTRAL WINDOW SCALING SHOULD BE
C                  APPLIED:
C                      0  DO NOT SCALE.
C                      1  APPLY SPECTRAL WINDOW SCALING.
C  PSTCLR          DENOTES IF DATA SHOULD BE POST-COLORED OR NOT:
C                      0  DO NOT POST-COLOR.
C                      1  APPLY POST-COLORING.
C  NFMT1,EFMT1     THE FORMATS OF THE FOURIER COEFFICIENT INPUT DATASETS.
C  U,V             ARRAYS FOR THE FOURIER COEFFICIENT INPUT DATASETS.
C  ISTART          ARRAY CONTAINING THE POSITIONS IN THE FOURIER COEFFI-
C                  CIENT ARRAYS WHERE DIFFERENT NN VALUES ARE USED DURING
C                  BLOCK AVERAGING.
C  NNS             ARRAY OF DIFFERENT NN VALUES TO USE WHEN BLOCK AVERA-
C                  GING.
C
C
C      VARIABLE LIST
C
C  IN              FORTRAN UNIT REFERENCE NUMBER OF INPUT FILE.
C  OUT             FORTRAN UNIT REFERENCE NUMBER OF OUTPUT FILE.
C  PERIOD          THE FIRST(AND LARGEST) PERIOD,IN HOURS,ASSOCIATED WITH
C                  FOURIER COEFFICIENTS.
C  IASIZE          THE LENGTH OF THE 'G' ARRAYS. THIS NUMBER,ALONG WITH
C                  THE SIZES OF THE 'G' ARRAYS SHOULD BE ADJUSTED TO
C                  COMPENSATE FOR CORE REGION AND TURN-AROUND TIME.
C  P               A PERIOD(IN HOURS) ASSOCIATED WITH OUTPUT VALUES.
C  F               A FREQUENCY(IN CYCLES/HOUR) ASSOCIATED WITH OUTPUT
C                  VALUES.
C  NDOF            THE NUMBER OF DEGREES OF FREEDOM.
C  SIGLVL          THE 90% SIGNIFICANCE LEVEL VALUE FOR COHERENCE ASSOCIA-
C                  TED WITH A GIVEN NODE.
C  NOUT            A COUNTER FOR THE NUMBER OF OUTPUT LINES.
C  INPUT           THE INDEX FOR THE INPUT(FOURIER COEFFICIENT) ARRAYS.
C                  IT ALWAYS POINTS TO THE NEXT VALUE TO BE USED.
C  LENCON          THE NUMBER OF VALUES TO CONVOLUTION AVERAGE.
C  LENG            THE NUMBER OF VALUES IN THE 'G' ARRAYS.
C  NUMB            THE NUMBER OF AVERAGED VALUES IN THE 'G' ARRAYS AFTER
C                  AVERAGING.
C  NNX2            TWO TIMES NN.
C  LEFT            THE NUMBER OF ESTIMATES LEFT TO AVERAGE AFTER THE
C                  FULL 'G' ARRAYS HAVE BEEN AVERAGED.
```

```
C  NTA            THE NUMBER OF TIMES TO AVERAGE FULL 'G' ARRAYS.
C  LARRAY         THE NUMBER OF ELEMENTS IN THE 'G' ARRAYS TO BE BLOCK
C                 AVERAGED.
C  NBLOCK         THE NUMBER OF BLOCKS TO BE BLOCK AVERAGED.
C  NBLPRA         THE NUMBER OF BLOCKS PER 'G' ARRAY TO AVERAGE.
C  CL             THE MULTIPLICATIVE FACTOR USED IN DETERMINING THE
C                 LOWER VALUE OF THE CONFIDENCE INTERVAL FOR SPECTRAL
C                 ESTIMATES.
C  CU             THE MULTIPLICATIVE FACTOR USED IN DETERMINING THE
C                 UPPER VALUE OF THE CONFIDENCE INTERVAL FOR SPECTRAL
C                 ESTIMATES.
C  GMM            A SPECTRAL ENERGY DENSITY ESTIMATE ASSOCIATED WITH THE
C                 CLOCKWISE COMPONENT OF THE VELOCITY HODOGRAPH ELLIPSE.
C  GPP            A SPECTRAL ENERGY DENSITY ESTIMATE ASSOCIATED WITH THE
C                 ANTICLOCKWISE COMPONENT OF THE VELOCITY HODOGRAPH
C                 ELLIPSE.
C  G11            AN AUTOSPECTRAL ESTIMATE OF THE NORTH COMPONENT.
C  G22            AN AUTOSPECTRAL ESTIMATE OF THE EAST COMPONENT.
C  G12            A CROSS-SPECTRAL ESTIMATE BETWEEN THE NORTH AND EAST
C                 COMPONENTS.
C  'G' ARRAYS     COLLECTIVE TERM FOR GPP,GMM,G11,G22,G12.
C  ALPHA          THE ORIENTATION OF THE VELOCITY HODOGRAPH ELLIPSE SEMI
C                 MAJOR AXIS MEASURED ANTICLOCKWISE IN DEGREES FROM EAST
C  GAMMA2         THE STABILITY OF THE VELOCITY HODOGRAPH ELLIPSE OR THE
C                 COHERENCE SQUARED BETWEEN THE ANTICLOCKWISE AND THE
C                 CLOCKWISE ROTATING COMPONENTS.
C  MAX            THE AMPLITUDE IN CM/SEC OF THE SEMI-MAJOR AXIS OF THE
C                 VELOCITY HODOGRAPH ELLIPSE.
C  MINMAX         THE RATIO OF THE SEMI-MAJOR TO SEMI-MINOR AXES OF THE
C                 VELOCITY HODOGRAPH ELLIPSE.
C  G2MIN          THE MINIMUM COHERENCE SQUARED BETWEEN ORTHOGONAL
C                 VELOCITY COMPONENTS. IT IS COMPUTED RELATIVE TO A CO-
C                 ORDINATE SYSTEM WHICH IS CO-AXIAL WITH THE NORMAL CO-
C                 ORDINATES OF THE VELOCITY HODOGRAPH ELLIPSE.
C  G2MAX          THE MAXIMUM COHERENCE SQUARED BETWEEN ORTHOGONAL
C                 VELOCITY COMPONENTS. IT IS COMPUTED RELATIVE TO A CO-
C                 ORDINATE SYSTEM WHICH IS ROTATED 45 DEGREES FROM THE
C                 NORMAL COORDINATES OF THE VELOCITY HODOGRAPH ELLIPSE.
C  ICNINT         FORTRAN UNIT REFERENCE NUMBER FOR THE CONFIDENCE INTER
C                 VAL PLOTTING DATASET.
C  I,J,K,L        INDEXES.
C
      COMPLEX U(4097),V(4097),G12(100)
      REAL GPP(100),GMM(100),G11(100),G22(100),MAX,MINMAX
      INTEGER ISTART(30),NNS(30),OUT,OUTCI,OUTPLT
      INTEGER PSTCLR
      COMMON U,V,G12,GPP,GMM,G11,G22,ALPHA,GAMMA2,MAX,MINMAX,
     *       G2MIN,G2MAX
      IASIZE=100
      IN=5
      DO 9999 INDS=17,19,2
```

```
C
C  SET FORTRAN UNIT REFERENCE NUMBERS FOR INPUT AND OUTPUT FILES.
C
      OUT=22+(INDS-17)/2
      OUTPLT=INDS/2+4
      OUTCI=INDS/2+6
C
C  INPUT PARAMETERS AND ECHO CHECK.
C
      READ(INDS,2001)LTRANS,LENGTH,NWINDO
 2001 FORMAT(2I5,I1)
      WRITE(6,1101)
 1101 FORMAT(' INPUT STEP,PSTCLR,IWSOPT,IOPT,NN,NUMBNN')
      READ(IN,2002)STEP,PSTCLR,IWSOPT,IOPT,NN,NUMBNN
 2002 FORMAT(F10.0,5I5)
      NINPUT=LTRANS/2+1
      WRITE(6,1102)LTRANS,LENGTH,NWINDO,STEP,PSTCLR,IWSOPT,IOPT,NN,
     *               NUMBNN,NINPUT
 1102 FORMAT(/// ',5X,'LTRANS',4X,'LENGTH',5X,'NWINDO   STEP',7X,
     *       'PSTCLR'// ',3I10,F10.3,I10// ',6X,'IWSOPT',5X,
     *       'IOPT',7X,'NN',6X,'NUMBNN   NINPUT'// ',5I10)
C
C  INPUT THE FOURIER COEFFICIENTS FOR THE U AND V COMPONENTS OF TIME
C  SERIES VELOCITY DATA. THEY SHOULD BE COMPLEX NUMBERS IN THE FORM
C  A-BI.
C
      READ(INDS,1103) (V(I),I=1,NINPUT)
 1103 FORMAT(2A6)
      INDSP1=INDS+1
      READ(INDSP1,1103) (U(I),I=1,NINPUT)
 6500 FORMAT(A6)
C
C  INITIALIZE VARIABLES.
C
      IF(IWSOPT.EQ.1)NWINDO=NWINDO+10
      PERIOD=LTRANS*STEP
      NOUT=0
      LENCON=NINPUT
C
C  IF ONLY PERFORMING CONVOLUTION AVERAGING,SKIP OVER SECTION INPUTTING
C  START AND NN VALUES FOR BLOCK AVERAGING. IF NOT,INPUT AND ECHO CHECK
C  THESE VALUES.
C
      IF(IOPT.NE.2)GO TO 49
         NUMOUT=LTRANS/2
         WRITE(OUTPLT,6500)NUMOUT
         J=1
         WRITE(OUTCI,1005)J
         GO TO 50
   49 WRITE(6,1008)
 1008 FORMAT(/// ',17X,'INDEX',5X,'START',6X,'NN')
      READ(IN,2004) (ISTART(I),NNS(I),I=1,NUMBNN)
 2004 FORMAT(14I5)
```

```
      WRITE(6,1009)(I,ISTART(I),NNS(I),I=1,NUMBNN)
 1009 FORMAT(' ',10X,3I10)
      NUMOUT=0
      IF(IOPT.EQ.3.AND.(ISTART(1)-NN-2).GT.0)NUMOUT=ISTART(1)-NN-2
      J=NUMBNN-1
      DO 48 I=1,J
         NUMOUT=NUMOUT+(ISTART(I+1)-ISTART(I))/(NNS(I)*2+1)
   48    CONTINUE
      NUMOUT=NUMOUT+(NINPUT-ISTART(NUMBNN))/(NNS(NUMBNN)*2+1)
      WRITE(OUTPLT,6500)NUMOUT
      J=NUMBNN+1
      IF(IOPT.NE.3)J=J-1
      WRITE(OUTCI,1005)J
      LENCON=ISTART(1)-1
C
C  OUTPUT HEADINGS.
C
   50 WRITE(OUT,1001)
C
C  IF ONLY PERFORMING BLOCK AVERAGING,SKIP OVER THE SECTION IMPLEMEN-
C  TING CONVOLUTION AVERAGING.
C
      IF(IOPT.LT.2.OR.LENCON.LT.(NN+1))GO TO 40
C
C
C  CONVOLUTION AVERAGING.
C
C
C  CALCULATE AND OUTPUT THE NUMBER OF DEGREES OF FREEDOM AND THE CORRE-
C  SPONDING CONFIDENCE INTERVAL MULTIPLICATIVE FACTORS AND SIGNIFI-
C  CANCE LEVEL.
C
      NDOF=2*(2*NN+1)*LENGTH/LTRANS
      CALL CONINT(NDOF,CU,CL)
      SIGLVL=SL(NDOF)
      F=1./PERIOD
      IF(NDOF.LT.3)CU=-CU
      WRITE(OUTCI,1005)F,CU,CL
 1005 FORMAT(3A6)
      WRITE(OUT,3002)NN,NDOF,SIGLVL,CU,CL
C
C  INITIALIZE VARIABLES ASSOCIATED WITH CONVOLUTION AVERAGING.
C
      INPUT=1
      NUMB=IASIZE-2*NN
      P=0.
      F=0.
      LENG=IASIZE
      IF(IASIZE.GT.(LENCON+NN))LENG=LENCON+NN
      K=NN+1
C
C  NOW FILL THE 'G' ARRAYS WITH UNAVERAGED VALUES. ESTIMATES MUST BE
C  'FOLDED' AROUND THE FIRST FREQUENCY ESTIMATE.
C
```

RSPEC (CONT'D.)

```
    DO 11 I=K,LENG
      CALL CALC(INPUT,I,STEP,LENGTH,NINPUT,PSTCLR,NWINDO)
      INPUT=INPUT+1
  11  CONTINUE
    NNX2=NN*2
    DO 12 I=1,NN
      J=NNX2+2-I
      CALL SWAP(I,J)
  12  CONTINUE
C
C IF THE 'G' ARRAYS ARE NOT FULL, SKIP THE SECTION AVERAGING FULL
C ARRAYS.
C
    IF(IASIZE.GT.(LENCON+NN))GO TO 52
    NTA=1+(LENCON-(IASIZE-NN))/(IASIZE-NNX2)
C
C THIS LOOP AVERAGES FULL ARRAYS,OUTPUTS ROTARY SPECTRA STATISTICS,
C MOVES VALUES TO THE TOPS OF THE ARRAYS, AND REFILLS THE REMAINDERS
C OF THE ARRAYS.
C
    DO 19 K=1,NTA
    CALL AVRG(IASIZE,NN)
C
C THIS LOOP OUTPUTS THE STATISTICS ALONG WITH THE ASSOCIATED PERIODS
C AND FREQUENCIES.
C
     DO 16 I=1,NUMB
       NOUT=NOUT+1
       CALL STAT(I,STEP,LTRANS)
       WRITE(OUT,1003)NOUT,F,P,GPP(I),GMM(I),ALPHA,GAMMA2,MAX,
      *         MINMAX,G2MIN,G2MAX
       IF(F.NE.0.)WRITE(OUTPLT,4000)F,GPP(I),GMM(I),ALPHA,GAMMA2,
      *                    MINMAX,G2MIN,G2MAX
 4000 FORMAT(8A6)
      IF(NOUT/60*EQ.NOUT)WRITE(OUT,1004)
 1004 FORMAT('1'///)
      P=PERIOD/FLOAT(NOUT)
      F=1./P
  16  CONTINUE
C
C NOW MOVE THE LAST 2*NN ELEMENTS TO THE TOPS OF THE 'G' ARRAYS.
C
    J=IASIZE-NNX2
    DO 17 I=1,NNX2
      J=J+1
      CALL SWAP(I,J)
  17  CONTINUE
C
C REFILL THE 'G' ARRAYS UNLESS GOING THROUGH THE LOOP FOR THE LAST
C TIME.
C
    IF(K.EQ.NTA)GO TO 19
```

```
      J=NNX2+1
      DO 18 I=J,IASIZE
         CALL CALC(INPUT,I,STEP,LENGTH,NINPUT,PSTCLR,NWINDO)
         INPUT=INPUT+1
   18    CONTINUE
   19 CONTINUE
C
C  IF NECESSARY PLACE THE REMAINING VALUES IN THE 'G' ARRAYS.
C
      LEFT=LENCON-(INPUT-1)
      LENG=NNX2+LEFT
      IF(LEFT.LT.1)GO TO 52
      J=NNX2+1
      DO 51 I=J,LENG
         CALL CALC(INPUT,I,STEP,LENGTH,NINPUT,PSTCLR,NWINDO)
         INPUT=INPUT+1
   51    CONTINUE
C
C  IF NO NEED TO 'FOLD'AROUND THE LAST ESTIMATE SKIP THIS SECTION.
C
   52 IF(IOPT.GT.2.OR.NN.EQ.0)GO TO 55
      J=LENG+NN
      IF(J.GT.IASIZE)J=IASIZE
      I=LENG+1
      LENG=LENG+NN
C
C  'FOLD'AROUND THE LAST ESTIMATE UNLESS THERE ISN'T ENOUGH ROOM IN THE
C  'G' ARRAYS TO DO SO.
C
      IF(I.GT.IASIZE)GO TO 59
      K=I-1
      L=I
      DO 54 I=L,J
         K=K-1
         CALL SWAP(I,K)
   54    CONTINUE
C
C  IF THE 'G' ARRAYS ARE NOT FULL, SKIP TO THE SECTION FOR HANDLING PAR-
C  TIALLY EMPTY ARRAYS. OTHERWISE,AVERAGE THE ESTIMATES AND OUTPUT THE
C  ROTARY SPECTRA STATISTICS ALONG WITH THE ASSOCIATED PERIODS AND FRE-
C  QUENCIES.
C
      IF(LENG.LE.IASIZE)GO TO 55
   59 CALL AVRG(IASIZE,NN)
      DO 56 I=1,NUMB
         NOUT=NOUT+1
         CALL STAT(I,STEP,LTRANS)
         WRITE(OUT,1003)NOUT,F,P,GPP(I),GMM(I),ALPHA,GAMMA2,MAX,
     *                     MINMAX,G2MIN,G2MAX
         IF(F.NE.0.)WRITE(OUTPLT,4000)F,GPP(I),GMM(I),ALPHA,GAMMA2,
     *                     MINMAX,G2MIN,G2MAX
         IF(NOUT/60*60.EQ.NOUT)WRITE(OUT,1004)
         P=PERIOD/FLOAT(NOUT)
         F=1./P
   56    CONTINUE
C
C  NOW MOVE THE LAST 2◆NN VALUES TO THE TOPS OF THE 'G' ARRAYS AND
C  'FOLD' AROUND THE LAST ESTIMATE.
C
      J=IASIZE-NNX2
      DO 57 I=1,NNX2
          J=J+1
          CALL SWAP(I,J)
   57     CONTINUE
      LENG=LENG-IASIZE+NNX2
      L=LENG-NNX2
      J=L+LENG-NNX2-1
      K=LENG+1
      DO 58 I=L,J
         K=K-1
         CALL SWAP(K,I)
   58    CONTINUE
   55 IF(LENG.EQ.0)GO TO 60
C
C  THIS SECTION IS FOR AVERAGING AND OUTPUTTING VALUES WHEN THE 'G'
C  ARRAYS ARE ONLY PARTIALLY FULL.
C
      CALL AVRG(LENG,NN)
      NUMB=LENG-2◆NN
      DO 53 I=1,NUMB
         NOUT=NOUT+1
          CALL STAT(I,STEP,LTRANS)
          WRITE(OUT,1003)NOUT,F,P,GPP(I),GMM(I),ALPHA,GAMMA2,MAX,
     ◆                 MINMAX,G2MIN,G2MAX
          IF(F.NE.0.)WRITE(OUTPLT,4000)F,GPP(I),GMM(I),ALPHA,GAMMA2,
     ◆                                MINMAX,G2MIN,G2MAX
          IF(NOUT/60◆60.EQ.NOUT)WRITE(OUT,1004)
          P=PERIOD/FLOAT(NOUT)
          F=1./P
   53     CONTINUE
C
C  TERMINATE THE PROGRAM UNLESS BLOCK AVERAGING IS TO ALSO BE IMPLE-
C  MENTED.
C
   60 IF(IOPT.GT.2)GO TO 40
      GO TO 9999
C
C
C  BLOCK AVERAGING.
C
C
   40 ISTART(NUMBNN+1)=NINPUT
C
C  PERFORM BLOCK AVERAGING USING NUMBNN BLOCK SIZES.
C
```

```
      DO 33 K=1,NUMBNN
C
C     CALCULATE VALUES BASED ON THE SIZE OF THE AVERAGING INTERVAL. ALSO,
C     DETERMINE AND OUTPUT THE NUMBER OF DEGREES OF FREEDOM AND ITS ASSO-
C     CIATED SIGNIFICANCE LEVEL AND CONFIDENCE INTERVAL FACTORS.
C
      NN=NNS(K)
      LENGAV=2◆NN+1
      INPUT=(ISTART(K)
      NBLOCK=(ISTART(K+1)-ISTART(K))/LENGAV
      NBLPRA=IASIZE/LENGAV
      NTA=NBLOCK/NBLPRA
      NDOF=2◆(2◆NN+1)◆LENGTH/LTRANS
      CALL CONINT(NDOF,CU,CL)
      SIGLVL=SL(NDOF)
      F=FLOAT(ISTART(K)+NN-1/PERIOD
      IF(NDOF.LT.3)CU=-CU
      WRITE(OUTCI,1005)F,CU,CL
      WRITE(OUT,3002)NN,NDOF,SIGLVL,CU,CL
 3002 FORMAT(6X,'NN=',I3,4X,'DEGREES OF FREEDOM=',I3,4X,
     ◆       'SIGNIFICANCE LEVEL=',F4.2,'  CONFIDENCE INTERVAL ',
     ◆       'FACTORS=(',F5.2,',',F5.2,')')
      I=1
      IF(NTA.EQ.0) GO TO 34
      LARRAY=NBLPRA◆LENGAV
C
C     THIS LOOP FILLS THE 'G' ARRAYS,AVERAGES THE ESTIMATES,AND OUTPUTS THE
C     ROTARY SPECTRA STATISTICS.
C
      DO 24 I=1,NTA
C
C     THIS LOOP FILLS THE 'G' ARRAYS COMPLETELY.
C
         DO 25 J=1,LARRAY
            CALL CALC(INPUT,J,STEP,LENGTH,NINPUT,PSTCLR,NWINDO)
            INPUT=INPUT+1
   25       CONTINUE
         CALL BAVRG(NBLPRA,NN)
C
C     NOW OUTPUT THE ROTARY SPECTRA STATISTICS WITH THE ASSOCIATED PERIODS
C     AND FREQUENCIES.
C
         DO 26 J=1,NBLPRA
            NOUT=NOUT+1
            CALL STAT(J,STEP,LTRANS)
            P=PERIOD/FLOAT(ISTART(K)+(I-1)◆LARRAY+(J-1)◆LENGAV+NN-1)
            F=1./P
            WRITE(OUT,1003)NOUT,F,P,GPP(J),GMM(J),ALPHA,GAMMA2,MAX,
     ◆                     MINMAX,G2MIN,G2MAX
        WRITE(OUTPLT,4000)F,GPP(J),GMM(J),ALPHA,GAMMA2,MINMAX,G2MIN,
     ◆                        G2MAX
            IF(NOUT/60◆60.EQ.NOUT)WRITE(OUT,1004)
   26        CONTINUE
   24     CONTINUE
C
C  THIS SECTION IS FOR THE SITUATION WHEN THE 'G' ARRAYS CANNOT BE COM-
C  PLETELY FILLED.
C
      I=NTA+1
   34 NBLPRA=NBLOCK-NTA*NBLPRA
      IF(NBLPRA.EQ.0)GO TO 33
C
C  FILL AS MUCH OF THE 'G' ARRAYS AS POSSIBLE USING THE REMAINDER OF THE
C  INPUT VALUES.
C
      LARRAY=NBLPRA*LENGAV
      DO 31 J=1,LARRAY
         CALL CALC(INPUT,J,STEP,LENGTH,MINPUT,PSTCLR,NWINDO)
         INPUT=INPUT+1
   31    CONTINUE
C
C  AVERAGE THE ESTIMATES IN THE 'G' ARRAYS AND OUTPUT THE ROTARY SPECTRA
C  STATISTICS.
C
      CALL BAVRG(NBLPRA,NN)
      LARRAY=IASIZE/LENGAV*LENGAV
      DO 32 J=1,NBLPRA
         NOUT=NOUT+1
         CALL STAT(J,STEP,LTRANS)
         P=PERIOD/FLOAT(ISTART(K)+(I-1)*LARRAY+(J-1)*LENGAV+NN-1)
         F=1./P
         WRITE(OUT,1003)NOUT,F,P,GPP(J),GMM(J),ALPHA,GAMMA2,MAX,
     *                  MINMAX,G2MIN,G2MAX
         WRITE(OUTPLT,4000)F,GPP(J),GMM(J),ALPHA,GAMMA2,MINMAX,G2MIN,
     *                         G2MAX
         IF(NOUT/60*60.EQ.NOUT)WRITE(OUT,1004)
   32    CONTINUE
   33 CONTINUE
 1001 FORMAT('    INDEX   FREQ',4X,'PERIOD   ANTICLOCKWISE',6X,'CLOCKWISE',
     *          5X,'ORIENTATION   STABILITY    SMAJOR',4X,'RATIO    CMIN**2',
     *          2X,'CMAX**2'/'  ',10X,'CPH',5X,'HOURS  (CM/S)**2/C.P.H.  ',
     *         '(CM/S)**2/C.P.H.    DEGREES',17X,'CM/S'/)
 1003 FORMAT(' ',I5,F9.5,F9.2,F13.2,F17.2,F14.4,F10.2,F11.2,F10.3,F8.2,
     *              F9.2)
 9999 CONTINUE
      STOP
      END
```

III. B.1 CALC

```
      SUBROUTINE CALC(INPUT,I,STEP,LENGTH,NINPUT,PSTCLR,NWINDO)
C
C     THIS SUBROUTINE CALCULATES ONE VALUE IN EACH OF THE 'G' ARRAYS GIVEN
C     ONE VALUE FROM EACH OF THE INPUT ARRAYS. IF THE USER DESIRES THEM,
C     POST-COLORING AND/OR SPECTRAL WINDOW SCALING ARE IMPLEMENTED IN THIS
C     ROUTINE.
C
C
C        VARIABLE LIST
C
C     INPUT           THE POSITION IN THE INPUT ARRAYS OF FOURIER COEFFI-
C                     CIENTS TO USE TO CALCULATE THE VALUES FOR THE 'G'
C                     ARRAYS.
C     I               THE POSITION IN THE 'G' ARRAYS TO STORE THE CALCULATED
C                     VALUES.
C     STEP            THE TIME INCREMENT(IN HOURS) BETWEEN VALUES USED IN
C                     COMPUTING THE FOURIER COEFFICIENTS.
C     LENGTH          THE NUMBER OF POINTS IN THE ORIGINAL TIME SERIES.
C     NINPUT          THE NUMBER OF FOURIER COEFFICIENTS INPUT.
C     PSTCLR          DENOTES IF THE DATA SHOULD BE POST-COLORED OR NOT:
C                          0  DO NOT POST-COLOR.
C                          1  APPLY POST-COLORING.
C     NWINDO          DENOTES THE TYPE OF SPECTRAL WINDOW USED WHEN COMPU-
C                     TING FOURIER COEFFICIENTS AND IF SPECTRAL WINDOW
C                     SCALING SHOULD BE PERFORMED:
C                          0  BOXCAR(NO) WINDOW.
C                          1  10% COSINE WINDOW.
C                          2  HANNING WINDOW.
C                          3  HAMMING WINDOW.
C                          4  PARZEN WINDOW.
C                          5  LANCZOS WINDOW.
C                     IF THE VALUE OF NWINDO IS GREATER THAN 10,THEN SPECTRAL
C                     WINDOW SCALING SHOULD BE PERFORMED USING SPECTRAL WIN-
C                     DOW NWINDO-10.
C     PI              PI.
C     FACTOR          MULTIPLICATIVE SCALING FACTOR. INITIALLY EQUAL TO STEP/
C                     LENGTH,BUT MAY BE CHANGED BY POST-COLORING AND/OR
C                     SPECTRAL WINDOW SCALING.
C     UP              ANTICLOCKWISE COMPLEX FOURIER COEFFICIENT.
C     UM              CLOCKWISE COMPLEX FOURIER COEFFICIENT.
C     GMM             A SPECTRAL ENERGY DENSITY ESTIMATE ASSOCIATED WITH THE
C                     CLOCKWISE COMPONENT OF THE VELOCITY HODOGRAPH ELLIPSE.
C     GPP             A SPECTRAL ENERGY DENSITY ESTIMATE ASSOCIATED WITH THE
C                     ANTICLOCKWISE COMPONENT OF THE VELOCITY HODOGRAPH
C                     ELLIPSE.
C     G11             AN AUTOSPECTRAL ESTIMATE OF THE NORTH COMPONENT.
C     G22             AN AUTOSPECTRAL ESTIMATE OF THE EAST COMPONENT.
```

CALC (CONT'D.)

```
C  G12           A CROSS-SPECTRAL ESTIMATE BETWEEN THE NORTH AND EAST
C                COMPONENTS.
C  'G' ARRAYS    COLLECTIVE TERM FOR GPP,GMM,G11,G22,G12.
C  U,V           COMPLEX FOURIER COEFFICIENTS COMPUTED FROM TIME SERIES
C                DATA BY AN FFT.
C
      COMPLEX U(4097),V(4097),G12(100),UP,UM
      REAL GPP(100),GMM(100),G11(100),G22(100)
      INTEGER PSTCLR
      COMMON U,V,G12,GPP,GMM,G11,G22
      PI=3,1415927
      FACTOR=STEP/FLOAT(LENGTH)
C
C DETERMINE IF POST-COLORING SHOULD BE IMPLEMENTED. IF SO, MODIFY THE
C VALUE OF FACTOR TO REFLECT THIS.
C
      IF(PSTCLR.NE.1)GO TO 10
C
C TEST FOR POSSIBLE DIVIDE CHECK PROBLEMS. IF FOUND,DIVIDE FACTOR BY A
C DEFAULT VALUE.
C
        IF(INPUT.NE.1.AND.(PI*FLOAT(INPUT-1)/(FLOAT(NINPUT-1)*2.))
     *       .NE.0)GO TO 12
          FACTOR=FACTOR/.000001
          GO TO 10
 12     FACTOR=FACTOR/(4.*SIN(PI*FLOAT(INPUT-1)/
     *           (FLOAT(NINPUT-1)*2.))**2)
C
C DETERMINE IF SPECTRAL WINDOW SCALING SHOULD BE IMPLEMENTED. IF SO,
C MODIFY THE VALUE OF FACTOR TO REFLECT THIS.
C
 10 IF(NWINDO.LT.11)GO TO 11
        N=NWINDO-10
        GO TO(1,2,3,4,5),N
  1     FACTOR=FACTOR/.873238
        GO TO 11
  2     FACTOR=FACTOR/.374245
        GO TO 11
  3     FACTOR=FACTOR/.396612
        GO TO 11
  4     FACTOR=FACTOR/.269099
        GO TO 11
  5     FACTOR=FACTOR/.450503
 11     UP=U(INPUT)+(0.,1.)*V(INPUT)
        UM=U(INPUT)-(0.,1.)*V(INPUT)
C
C COMPUTE VALUES FOR THE 'G' ARRAYS.
C
        GPP(I)=REAL(CONJG(UP)*UP)*FACTOR
        GMM(I)=REAL(CONJG(UM)*UM)*FACTOR
        G11(I)=REAL(CONJG(U(INPUT))*U(INPUT))*2
        G22(I)=REAL(CONJG(V(INPUT))*V(INPUT))*2
        G12(I)=CONJG(U(INPUT))*V(INPUT)*2
      RETURN
      END
```

III. B.2 SWAP

```
      SUBROUTINE SWAP(I,J)
C
C  THIS SUBROUTINE MOVES VALUES IN THE 'G' ARRAYS AT POSITION J TO
C  POSITION I.
C
C
C       VARIABLE LIST
C
C  J                  LOCATION OF VALUES IN THE 'G' ARRAYS TO BE MOVED.
C  I                  LOCATION IN THE 'G' ARRAYS WHERE VALUES ARE MOVED TO.
C_
      COMPLEX U(4097),V(4097),G12(100)
      REAL GPP(100),GMM(100),G11(100),G22(100)
      COMMON U,V,G12,GPP,GMM,G11,G22
         GPP(I)=GPP(J)
         GMM(I)=GMM(J)
         G11(I)=G11(J)
         G22(I)=G22(J)
         G12(I)=G12(J)
      RETURN
      END
```

III. B.3 AVRG

```
      SUBROUTINE AVRG(LENG,NN)
C
C  THIS SUBROUTINE PERFORMS CONVOLUTION(RUNNING) AVERAGING ON THE 'G'
C  ARRAYS. THE AVERAGED ESTIMATES ARE STORED AT THE 'TOP' OF THE 'G'
C  ARRAYS.
C
C
C       VARIABLE LIST
C
C  LENG              THE NUMBER OF ESTIMATES IN THE 'G' ARRAYS TO BE IN-
C                    VOLVED IN AVERAGING.
C  NN                THE NUMBER OF ADJACENT FREQUENCY BANDS TO AVERAGE
C                    OVER.
C  NAVRG             THE ACTUAL NUMBER OF ESTIMATES TO AVERAGE OVER.
C  RAVRG             SAME AS NAVRG BUT REAL.
C  NUMB              THE NUMBER OF AVERAGED ESTIMATES TO BE CALCULATED.
C  NUMBM1            NUMB(ABOVE)-1.
C  SUM1-SUM5         RUNNING SUMS OF NAVRG ESTIMATES IN THE 'U' ARRAYS.
C  A1-A5             TEMPORARY VARIABLES USED TO SAVE ESTIMATES.
C  I,N               INDEXES.
C
      COMPLEX U(4097),V(4097),G12(100),SUM5,A5
      REAL GPP(100),GMM(100),G11(100),G22(100)
      COMMON U,V,G12,GPP,GMM,G11,G22
C
C  INITIALIZE VARIABLES.
C
      NAVRG=2*NN+1
      NUMB=LENG-2*NN
      RAVRG=FLOAT(NAVRG)
      NUMBM1=NUMB-1
      SUM1=0.
      SUM2=0.
      SUM3=0.
      SUM4=0.
      SUM5=CMPLX(0.,0.)
C
C  SUM FIRST NAVRG ESTIMATES.
C
      DO 14 J=1,NAVRG
         SUM1=SUM1+GPP(J)
         SUM2=SUM2+GMM(J)
         SUM3=SUM3+G11(J)
         SUM4=SUM4+G22(J)
         SUM5=SUM5+G12(J)
   14    CONTINUE
      IF(NUMBM1.LT.1)GO TO 16
```

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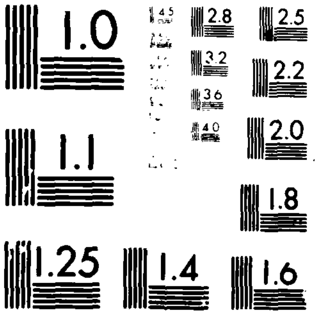

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AVRG (CONT'D.)

```
C
C  CALCULATE NUMBM1 AVERAGED ESTIMATES.
C
      DO 15 I=1,NUMBM1
C
C  SAVE ESTIMATES FOR LATER.
C
         A1=GPP(I)
         A2=GMM(I)
         A3=G11(I)
         A4=G22(I)
         A5=G12(I)
C
C  DIVIDE SUMS BY RAVRG TO CALCULATE AVERAGES AND STORE IN THE 'G'
C  ARRAYS.
C
         GPP(I)=SUM1/RAVRG
         GMM(I)=SUM2/RAVRG
         G11(I)=SUM3/RAVRG
         G22(I)=SUM4/RAVRG
         G12(I)=SUM5/RAVRG
C
C  DETERMINE SUMS FOR NEXT ESTIMATES.
C
         SUM1=SUM1-A1+GPP(I+NAVRG)
         SUM2=SUM2-A2+GMM(I+NAVRG)
         SUM3=SUM3-A3+G11(I+NAVRG)
         SUM4=SUM4-A4+G22(I+NAVRG)
         SUM5=SUM5-A5+G12(I+NAVRG)
   15    CONTINUE
C
C  DIVIDE SUMS BY RAVRG TO CALCULATE AVERAGES FOR FINAL ESTIMATES IN
C  THE 'G' ARRAYS.
C
   16 GPP(NUMB)=SUM1/RAVRG
      GMM(NUMB)=SUM2/RAVRG
      G11(NUMB)=SUM3/RAVRG
      G22(NUMB)=SUM4/RAVRG
      G12(NUMB)=SUM5/RAVRG
      RETURN
      END
```

III. B.4 BAVRG

```
      SUBROUTINE BAVRG(NUMBL,NN)
C
C  THIS SUBROUTINE PERFORMS BLOCK AVERAGING ON THE 'G' ARRAYS. AS
C  EACH BLOCK OF 2*NN+1 ELEMENTS IS AVERAGED,THE NEW VALUES ARE MOVED
C  TO THE TOP OF THE 'G' ARRAYS.
C
C
C      VARIABLE LIST
C
C  NUMBL          THE NUMBER OF BLOCKS TO BE AVERAGED.
C  NN             THE NUMBER OF ADJACENT FREQUENCY BANDS TO AVERAGE OVER.
C  NAVRG          THE ACTUAL NUMBER OF POINTS PER BLOCK TO AVERAGE.
C  AVRG           SAME AS NAVRG BUT REAL.
C  SUM1-SUM5      RUNNING SUMS OF THE ESTIMATES PER BLOCK OF THE 'G'
C                 ARRAYS.
C  I,J,K          INDEXES.
C  AU,AV,BU,BV    INPUT ARRAYS(ALSO USED TO STORE CO- AND QUAD- SPECTRAL
C                 ESTIMATES).
C
      COMPLEX U(4097),V(4097),G12(100),SUM5
      REAL GPP(100),GMM(100),G11(100),G22(100)
      COMMON U,V,G12,GPP,GMM,G11,G22
      NAVRG=2*NN+1
      AVRG=FLOAT(NAVRG)
C
C  AVERAGE NUMBL BLOCKS.
C
      DO 10 I=1,NUMBL
C
C  INITIALIZE SUMS TO ZERO.
C
         SUM1=0.
         SUM2=0.
         SUM3=0.
         SUM4=0.
         SUM5=CMPLX(0.,0.)
C
C  SUM NAVRG ESTIMATES.
C
         DO 11 J=1,NAVRG
            K=(I-1)*NAVRG+J
            SUM1=SUM1+GPP(K)
            SUM2=SUM2+GMM(K)
            SUM3=SUM3+G11(K)
            SUM4=SUM4+G22(K)
            SUM5=SUM5+G12(K)
   11       CONTINUE
```

BAVRG (CONT'D.)

```
C
C  DIVIDE BY AVRG TO CALCULATE AVERAGES AND STORE IN 'G' ARRAYS.
C
         GPP(I)=SUM1/AVRG
         GMM(I)=SUM2/AVRG
         G11(I)=SUM3/AVRG
         G22(I)=SUM4/AVRG
         G12(I)=SUM5/AVRG
   10    CONTINUE
      RETURN
      END
```

III. B.5 STAT

```
      SUBROUTINE STAT(I,STEP,LTRANS)
C
C  THIS SUBROUTINE CALCULATES ROTARY SPECTRAL ANALYSIS STATISTICS FROM
C  THE 'G' ARRAYS.
C
C
C     VARIABLE LIST
C
C  I              THE POSITION OF THE VALUES IN THE 'G' ARRAYS FROM
C                 WHICH THE STATISTICS ARE COMPUTED.
C  STEP           THE TIME INCREMENT (IN HOURS) BETWEEN THE TIME SERIES
C                 ESTIMATES.
C  PERIOD         THE FIRST(AND LARGEST) PERIOD,IN HOURS, ASSOCIATED WITH
C                 FOURIER COEFFICIENTS.
C  R2             COMMON FACTOR USED IN COMPUTING THE MINIMUM AND MAXIMUM
C                 COHERENCIES.
C  ALPHA          THE ORIENTATION OF THE VELOCITY HODOGRAPH ELLIPSE SEMI-
C                 MAJOR AXIS MEASURED ANTICLOCKWISE IN DEGREES FROM EAST.
C  GAMMA2         THE STABILITY OF THE VELOCITY HODOGRAPH ELLIPSE OR THE
C                 COHERENCE SQUARED BETWEEN THE ANTICLOCKWISE AND THE
C                 CLOCKWISE ROTATING COMPONENTS.
C  MAX            THE AMPLITUDE IN CM/SEC OF THE SEMI-MAJOR AXIS OF THE
C                 VELOCITY HODOGRAPH ELLIPSE.
C  MINMAX         THE RATIO OF THE SEMI-MAJOR TO SEMI-MINOR AXES OF THE
C                 VELOCITY HODOGRAPH ELLIPSE.
C  G2MIN          THE MINIMUM COHERENCE SQUARED BETWEEN ORTHOGONAL
C                 VELOCITY COMPONENTS. IT IS COMPUTED RELATIVE TO A CO-
C                 ORDINATE SYSTEM WHICH IS CO-AXIAL WITH THE NORMAL CO-
C                 ORDINATES OF THE VELOCITY HODOGRAPH ELLIPSE.
C  G2MAX          THE MAXIMUM COHERENCE SQUARED BETWEEN ORTHOGONAL
C                 VELOCITY COMPONENTS.  IT IS COMPUTED RELATIVE TO A CO-
C                 ORDINATE SYSTEM WHICH IS ROTATED 45 DEGREES FROM THE
C                 NORMAL COORDINATES OF THE VELOCITY HODOGRAPH ELLIPSE.
C  GMM            A SPECTRAL ENERGY DENSITY ESTIMATE ASSOCIATED WITH THE
C                 CLOCKWISE COMPONENT OF THE VELOCITY HODOGRAPH ELLIPSE.
C  GPP            A SPECTRAL ENERGY DENSITY ESTIMATE ASSOCIATED WITH THE
C                 ANTICLOCKWISE COMPONENT OF THE VELOCITY HODOGRAPH
C                 ELLIPSE.
C  G11            AN AUTOSPECTRAL ESTIMATE OF THE NORTH COMPONENT.
C  G22            AN AUSTOSPECTRAL ESTIMATE OF THE EAST COMPONENT.
C  G12            A CROSS-SPECTRAL ESTIMATE BETWEEN THE NORTH AND THE
C                 EAST COMPONENTS.
C  'G' ARRAYS     COLLECTIVE TERM FOR GPP,GMM,G11,G22,G12.
```

STAT (CONT'D.)

```
      COMPLEX U(4097),V(4097),G12(100)
      REAL GPP(100),GMM(100),G11(100),G22(100),MAX,MINMAX
      COMMON U,V,G12,GPP,GMM, G11,G2 ,ALPHA,GAMMA2,MAX,MINMAX,
     *       G2MIN,G2MAX
      RAD=180./3.14159265
      IF(G11(I).NE.G22(I))GO TO 10
         ALPHA=45.
         GO TO 11
   10 ALPHA=ATAN2(2.*REAL(G12(I)),G11(I)-G22(I))/2.*RAD
   11 GAMMA2=((G11(I)-G22(I))**2+4.*REAL(G12(I))**2)/((G11(I)+G22(I))**2
     *          -4.*AIMAG(G12(I))**2)
      MAX=SQRT(1./STEP/LTRANS)*(SQRT(GPP(I))+SQRT(GMM(I)))
      MINMAX=(SQRT(GPP(I))-SQRT(GMM(I)))/(SQRT(GPP(I))+SQRT(GMM(I)))
      R2=1./4.*(G11(I)+G22(I))**2-G11(I)*G22(I)+REAL(G12(I))**2
      G2MIN=AIMAG(G12(I))**2/(1./4.*(G11(I)+G22(I))**2-R2
      G2MAX=(R2+(AIMAG(G12(I))**2/(1./4.*(G11(I)+G22(I))**2)
      RETURN
      END
```

III. B.6 SL

```
      FUNCTION SL(NDOF)
C
C  THIS FUNCTION DETERMINES A 90% SIGNIFICANCE LEVEL FOR COHERENCIES
C  GIVEN THE NUMBER OF DEGREES OF FREEDOM. THESE VALUES WERE CALCU-
C  LATED FROM 'TABLE OF THE DISTRIBUTION OF THE COEFFICIENT OF COHERENCE
C  FOR STATIONARY BIVARIATE GAUSSIAN PROCESSES' BY AMOS AND KOOPMANS,
C  1963. THE RELATIONSHIP FOR VALUES ASSOCIATED WITH NDOF >=12 WAS FOUND
C  TO BE WITHIN 3% ACCURACY.
C
C
C       VARIABLE LIST
C
C  NDOF             THE NUMBER OF DEGREES OF FREEDOM.
C  SL               SIGNIFICANCE LEVEL.
C  N                POINTER.
C
      IF(NDOF.GT.11)GO TO 200
      N=NDOF+1
      GO TO(2,2,2,3,4,5,6,7,8,9,10,11),N
    2 SL=1.
      RETURN
    3 SL=.9900
      RETURN
    4 SL=.9000
      RETURN
    5 SL=.7845
      RETURN
    6 SL=.6838
      RETURN
    7 SL=.6019
      RETURN
    8 SL=.5359
      RETURN
    9 SL=.4822
      RETURN
   10 SL=.4377
      RETURN
   11 SL=.4005
      RETURN
  200 SL=4.5578/FLOAT(NDOF)
      RETURN
      END
```

III. B.7 CONINT

```
      SUBROUTINE CONINT(NDOF,CUPPER,CLOWER)
C  THIS SUBROUTINE CALCULATES A 90% CONFIDENCE INTERVAL FOR CLOCKWISE
C  AND ANTICLOCKWISE SPECTRAL ESTIMATES GIVEN THE NUMBER OF DEGREES OF
C  FREEDOM. THE MULTIPLICATIVE CONFIDENCE INTERVAL FACTORS ARE CALCU-
C  LATED FROM VALUES OF THE CHI SQUARE DISTRIBUTION.
C
C
C       VARIABLE LIST
C
C  NDOF             THE NUMBER OF DEGREES OF FREEDOM.
C  CUPPER           THE MULTIPLICATIVE FACTOR USED IN DETERMINING THE UPPER
C                   VALUE OF THE CONFIDENCE INTERVAL.
C  CLOWER           THE MULTIPLICATIVE FACTOR USED IN DETERMINING THE LOWER
C                   VALUE OF THE CONFIDENCE INTERVAL.
C  RNDOF            SAME AS NDOF BUT REAL.
C  CP05             ARRAY CONTAINING VALUES OF THE CHI SQUARF DISTRIBUTION
C                   USED IN CALCULATING THE LOWER VALUE OF THE CONFIDENCE
C                   INTERVAL.
C  CP95             ARRAY CONTAINING VALUES OF THE CHI SQUARE DISTRIBUTION
C                   USED IN CALCULATING THE UPPER VALUE OF THE CONFIDENCE
C                   INTERVAL.
C
      REAL CP05(39),CP95(39)
      DATA CP95/.004,.103,.352,.711,1.15,1.64,2.17,2.73,3.33,3.94,4.57,
     ◆          5.23,5.89,6.57,7.26,7.96,8.67,9.39,10.1,10.9,11.6,12.3,
     ◆          13.1,13.8,14.6,15.4,16.2,16.9,17.7,18.5,26.5,34.8,43.2,
     ◆          51.7,60.4,69.1,77.9,86.8,95.7/
      DATA CP05/3.84,5.99,7.81,9.49,11.1,12.6,14.1,15.6,16.9,18.3,19.7,
     ◆          21.0,22.4,23.7,25.,26.3,27.6,28.9,30.1,31.4,32.7,33.9,
     ◆          35.2,36.4,37.7,38.9,40.1,41.3,42.6,43.8,55.8,67.5,79.1,
     ◆          90.5,101.9,113.1,124.3,135.5,146.6/
C
C  IF LESS THAN 3 DEGREES OF FREEDOM SET UPPER AND LOWER FACTORS TO
C  DEFAULT VALUES SIGNIFYING THERE IS NO CONFIDENCE INTERVAL.
C
      IF(NDOF.GT.2)GO TO 50
      CUPPER=99.99
      CLOWER=00.00
      RETURN
C
C  IF LESS THAN 31 DEGREES OF FREEDOM(BUT MORE THAN 2),SET UPPER AND
C  LOWER CONFIDENCE INTERVAL FACTORS USING VALUES OF THE CHI SQUARE DIS-
C  TRIBUTION.
C
```

CONINT (CONT'D.)

```
   50 RNDOF=FLOAT(NDOF)
      IF(NDOF.GT.30)GO TO 100
      CUPPER=RNDOF/CP95(NDOF)
      CLOWER=RNDOF/CP05(NDOF)
      RETURN
C
C  IF LESS THAN 121 DEGREES OF FREEDOM(BUT MORE THAN 30),SET UPPER AND
C  LOWER CONFIDENCE INTERVAL FACTORS BY INTERPOLATING VALUES OF THE CHI
C  SQUARE DISTRIBUTION.
C
  100 IF(NDOF.GT.120) GO TO 200
      J=30+NDOF/10-3
      CUPPER=RNDOF/(CP95(J)+AMOD(RNDOF,10.)/10.*(CP95(J+1)-CP95(J)))
      CLOWER=RNDOF/(CP05(J)+AMOD(RNDOF,10.)/10.*(CP05(J+1)-CP05(J)))
      RETURN
C
C  IF GREATER THAN 120 DEGREES OF FREEDOM,SIMPLY SET THE UPPER AND
C  LOWER CONFIDENCE INTERVAL FACTORS TO THE VALUES FOR 120 DEGREES OF
C  FREEDOM. THIS SHOULD RARELY HAPPEN.
C
  200 CUPPER=1.25
      CLOWER=.82
      RETURN
      END
```

IV. A. RCSPEC

```
C
C  PROGRAM- RCSPEC
C  PROGRAMMER- JACK HICKMAN
C  DATE WRITTEN- MARCH,1979
C
C  THIS PROGRAM PERFORMS A ROTARY CROSS SPECTRAL ANALYSIS OF TIME SERIES
C  DATA. INPUT CONSISTS OF FOUR COMPLEX FOURIER COEFFICIENT DATASETS
C  (A U AND A V COMPONENT FROM EACH OF TWO TIME SERIES),VARIABLES
C  DESCRIBING THE TIME SERIES,AND VARIOUS USER SPECIFIED PARAMETERS.
C  THESE PARAMETERS ALLOW THE USER TO APPLY A VARIETY OF SCALING AND
C  AVERAGING COMBINATIONS. AVERAGING METHODS INCLUDE BLOCK AVERAGING
C  RESULTING IN INDEPENDENT ESTIMATES,CONVOLUTION AVERAGING PRODUCING
C  DEPENDENT ESTIMATES,OR A COMBINATION OF BOTH METHODS. GREAT CARE
C  WAS TAKEN IN THE WRITING OF THIS PROGRAM TO AVOID POTENTIAL CORE
C  REGION PROBLEMS. ALTHOUGH THE ARRAYS CONTAINING THE FOURIER COEFFI-
C  CIENTS MUST BE SUFFICIENTLY LARGE TO ACCOMMODATE ALL OF THE INPUT
C  DATA,THE 'U' ARRAYS,WHICH CONTAIN THE VALUES THAT ARE AVERAGED AND
C  THEN USED IN THE CALCULATION OF THE OUTPUT DATA,ARE OF VARIABLE
C  LENGTH. THE USER MAY ALTER THE SIZES OF THESE ARRAYS TO SUIT HIS
C  OR HER PARTICULAR DATA AND MACHINE. NATURALLY,THE SMALLER THE ARRAYS
C  ARE,THE MORE SWAPPING IS REQUIRED RESULTING IN GREATER EXECUTION
C  TIMES. THE ONLY RESTRICTION IS THAT THE SIZE OF THE 'U' ARRAYS MUST
C  BE GREATER THAN DOUBLE THE LARGEST NN VALUE USED. THE VALUE OF THE
C  VARIABLE 'IASIZE' MUST BE ALTERED TO REFLECT THE SIZE OF THE 'U'
C  ARRAYS.
C
C
C      SUBROUTINES REQUIRED
C
C              CALC
C              SWAP
C              AVRG
C              BAVRG
C              PHACOH
C              SL
C
C
C      INPUT PARAMETERS
C
C  LTRANS        THE SIZE OF THE FOURIER TRANSFORM APPLIED TO THE TIME
C                SERIES DATA.
C  STEP          THE TIME INCREMENT(IN HOURS) BETWEEN THE TIME SERIES
C                ESTIMATES.
C  LENGTH        THE NUMBER OF ESTIMATES IN THE TIME SERIES.
C  NINPUT        THE NUMBER OF FOURIER COEFFICIENTS INPUT.
C  IOPT          DETERMINES THE TYPE OF AVERAGING TO USE:
C                    1  BLOCK AVERAGING.
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C                          2  CONVOLUTION AVERAGING.
C                          3  COMBINATION OF BLOCK AND CONVOLUTION AVERAGING.
C  NN               THE NUMBER OF ADJACENT FREQUENCY BANDS TO AVERAGE OVER.
C  NUMBNN           THE NUMBER OF NN VALUES TO USE IF BLOCK AVERAGING.
C  NIN1,NIN2,       THE FORTRAN UNIT REFERENCE NUMBERS FOR THE FOURIER
C  EIN1,EIN2        COEFFICIENT DATASETS TO INPUT.
C  NWINDO           DENOTES THE TYPE OF SPECTRAL WINDOW USED WHEN COMPU-
C                   TING FOURIER COEFFICIENTS:
C                          0  BOXCAR(NO) WINDOW.
C                          1  10% COSINE WINDOW.
C                          2  HANNING WINDOW.
C                          3  HAMMING WINDOW.
C                          4  PARZEN WINDOW.
C                          5  LANCZOS WINDOW.
C  IWSOPT           DENOTES WHETHER SPECTRAL WINDOW SCALING SHOULD BE
C                   APPLIED:
C                          0  DO NOT SCALE.
C                          1  APPLY SPECTRAL WINDOW SCALING.
C  PSTCLR           DENOTES IF DATA SHOULD BE POST-COLORED OR NOT:
C                          0  DO NOT APPLY POST-COLORING.
C                          1  APPLY POST-COLORING.
C  NFMT1,NFMT2,     THE FORMATS OF THE COMPLEX FOURIER COEFFICIENT
C  EFMT1,EFMT2      DATASETS TO INPUT.
C  AU,AV,BU,BV      ARRAYS FOR THE INPUT FOURIER COEFFICIENTS.ALSO
C                   USED TO STORE CO- AND QUAD- SPECTRAL ESTIMATES.
C  ISTART           ARRAY CONTAINING THE POSITIONS IN THE FOURIER COEFFI-
C                   CIENT ARRAYS WHERE DIFFERENT NN VALUES ARE USED DURING
C                   BLOCK AVERAGING.
C  NNS              ARRAY OF DIFFERENT NN VALUES FOR USE WHEN BLOCK AVERA-
C                   GING.
C
C
C      VARIABLE LIST
C
C  IN               FORTRAN UNIT REFERENCE NUMBER OF INPUT FILE.
C  OUT              FORTRAN UNIT REFERENCE NUMBER OF OUTPUT FILE.
C  PERIOD           THE FIRST(AND LARGEST) PERIOD,IN HOURS,ASSOCIATED WITH
C                   THE FOURIER COEFFICIENTS.
C  IASIZE           THE LENGTH OF THE 'U' ARRAYS. THIS NUMBER,ALONG WITH
C                   THE SIZES OF THE 'U' ARRAYS SHOULD BE ADJUSTED TO
C                   COMPENSATE FOR CORE REGION AND TURN-AROUND TIME.
C  P                A PERIOD(IN HOURS) ASSOCIATED WITH OUTPUT VALUES.
C  F                A FREQUENCY(IN CYCLES/HOUR) ASSOCIATED WITH OUTPUT
C                   VALUES.
C  NDOF             THE NUMBER OF DEGREES OF FREEDOM.
C  SIGLVL           THE 90% SIGNIFICANCE LEVEL VALUE FOR COHERENCE ASSOCIA-
C                   TED WITH A GIVEN NDOF.
C  NOUT             A COUNTER FOR THE NUMBER OF OUTPUT LINES.
C  INPUT            THE INDEX FOR THE INPUT(FOURIER COEFFICIENTS) ARRAYS.
C                   IT ALWAYS POINTS TO THE NEXT VALUE TO BE USED.
C  NSTORE           ANOTHER INDEX FOR THE INPUT ARRAYS POINTING TO THE NEXT
C                   LOCATION AVAILABLE FOR STORING CO- AND QUAD- SPECTRAL
                    ESTIMATES.
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C  MINPUT          THE NUMBER OF PAIRS OF FOURIER COEFFICIENTS GENERATED
C                  BY THE FFT.
C  LENCON          THE NUMBER OF VALUES TO CONVOLUTION AVERAGE.
C  LENG            THE NUMBER OF VALUES IN THE 'U' ARRAYS.
C  NUMB            THE NUMBER OF AVERAGED VALUES IN THE 'U' ARRAYS AFTER
C                  AVERAGING.
C  NNX2            TWO TIMES NN.
C  LEFT            THE NUMBER OF ESTIMATES LEFT TO AVERAGE AFTER THE
C                  FULL 'U' ARRAYS HAVE BEEN AVERAGED.
C  COABNN,COABNP,  THE SQUARED COHERENCIES BETWEEN THE PAIRS OF POLARIZED
C  COABPN,COABPP   CONSTITUENTS AT LOCATIONS A AND B.
C  PHABNN,PHABNP,  THE PHASES FOR THE PAIRS OF POLARIZED CONSTITUENTS AT
C  PHABPN,PHABPP   LOCATIONS A AND B.
C  UACNAN,...,     PRODUCTS OF ANTICLOCKWISE AND/OR CLOCKWISE COMPLEX
C  UBCPBP          FOURIER COEFFICIENTS AT LOCATIONS A AND/OR B. ALSO
C                  KNOWN AS THE 'U' ARRAYS.
C  NTA             THE NUMBER OF TIMES TO AVERAGE FULL 'U' ARRAYS.
C  LARRAY          THE NUMBER OF ELEMENTS IN THE 'U' ARRAYS TO BE BLOCK
C                  AVERAGED.
C  NBLOCK          THE NUMBER OF BLOCKS TO BE BLOCK AVERAGED.
C  NBLPRA          THE NUMBER OF BLOCKS PER 'U' ARRAY TO AVERAGE.
C  I,J,K,L         INDEXES.
C
      COMPLEX AU(4097),AV(4097),BU(4097),BV(4097),
     ◆         UACPBP(50),UACNBN(50),UACPBN(50),UACNBP(50),
     ◆         UACPAP(50),UBCPBP(50),UACNAN(50),UBCNBN(50)
      INTEGER ISTART(30),NNS(30),OUT,OUTPLT,PSTCLR
      COMMON AU,AV,BU,BV,UACPBP,UACNBN,UACPBN,UACNBP,UACPAP,UBCPBP,
     ◆        UACNAN,UBCNBN,
     ◆        PHABPP,PHABNN,PHABPN,PHABNP,COABPP,COABNN,COABPN,COABNP
      IASIZE=50
C
C  SET FORTRAN REFERENCE NUMBERS FOR INPUT AND OUTPUT FILES.
C
      IN=5
      OUT=21
      OUTPLT=11
C
C  INPUT PARAMETERS AND ECHO CHECK.
C
      READ(17,2001)LTRANS,LENGTH,NWINDO
 2001 FORMAT(2I5,I1)
      WRITE(6,2003)
 2003 FORMAT(' INPUT STEP,PSTCLR,IWSOPT,IOPT,NN,NUMBNN')
      READ(IN,2002)STEP,PSTCLR,IWSOPT,IOPT,NN,NUMBNN
 2002 FORMAT(F10.0,6I5)
      MINPUT=LTRANS/2+1
      WRITE(6,1101)LTRANS,LENGTH,NWINDO,STEP,PSTCLR,IWSOPT,IOPT,NN,
     ◆             NUMBNN,MINPUT
 1101 FORMAT(/// ',5X,'LTRANS',4X,'LENGTH',5X,'NWINDO   STEP',7X,
     ◆        'PSTCLR'// ',3I10,F10.3,I10// ',6X,'IWSOPT',5X,
     ◆        'IOPT',7X,'NN',6X,'NUMBNN   MINPUT'// ',5I10)
```

```
C
C  INPUT FOUR SERIES OF FOURIER COEFFICIENTS: A U AND V COMPONENT
C  FROM EACH OF TWO TIME SERIES.
C
      READ(17,1103)(AV(I),I=1,NINPUT)
 1103 FORMAT(2A6)
      READ(18,2001)LTRANS,LENGTH,NWINDO
      READ(18,1103)(AU(I),I=1,NINPUT)
      READ(19,2001)LTRANS,LENGTH,NWINDO
      READ(19,1103)BV(I),I=1,NINPUT)
      READ(20,2001)LTRANS,LENGTH,NWINDO
      READ(20,1103)(BU(I),I=1,NINPUT)
 1001 FORMAT('    INDEX   FREQ      PERIOD',5X,'COH**2   PHASE(DEG)',2X,
     *         'COH**2   PHASE(DEG)   COH**2   PHASE(DEG)   COH**2',2X,
     *         'PHASE(DEG)'//' ',10X,'CPH',5X,'HOURS',7X,'++',8X,'++',8X,
     *         '--',8X,'--',8X,'+-',8X,'+-',8X,'-+',8X,'-+'/)
C
C  INITIALIZE VARIABLES.
C
      IF(IWSOPT.EQ.1)NWINDO=NWINDO+10
      PERIOD=LTRANS*STEP
      NSTORE=1
      NOUT=0
      LENCON=NINPUT
C
C  IF ONLY PERFORMING CONVOLUTION AVERAGING,SKIP OVER SECTION INPUT-
C  TING START AND NN VALUES FOR BLOCK AVERAGING. IF NOT,INPUT AND
C  ECHO CHECK THESE VALUES.
C
      IF(IOPT.NE.2)GO TO 49
         NUMOUT=LTRANS/2
         WRITE(OUTPLT,6500)NUMOUT
 6500    FORMAT(A6)
         GO TO 50
   49 WRITE(6,1008)
 1008 FORMAT(/// ',17X,'INDEX',5X,'START',6X,'NN'/)
      READ(IN,2004)(ISTART(I),NNS(I),I=1,NUMBNN)
 2004 FORMAT(14I5)
      WRITE(6,1009)(I,ISTART(I),NNS(I),I=1,NUMBNN)
 1009 FORMAT(' ',10X,3I10)
      NUMOUT=0
      IF(IOPT.EQ.3.AND.(ISTART(1)-NN-2).GT.0)NUMOUT=ISTART(1)-NN-2
      J=NUMBNN-1
      DO 48 I=1,J
         NUMOUT=NUMOUT+(ISTART(I+1)-ISTART(I))/(NNS(I)*2+1)
   48    CONTINUE
      NUMOUT=NUMOUT+(NINPUT-ISTART(NUMBNN))/(NNS(NUMBNN)*2+1)
      WRITE(OUTPLT,6500)NUMOUT
      LENCON=ISTART(1)-1
C
C  OUTPUT HEADINGS.
C
   50 WRITE(OUT,1001)
```

RCSPEC (CONT'D.)

```
C
C  IF ONLY PERFORMING BLOCK AVERAGING,SKIP OVER SECTION IMPLEMENTING
C  CONVOLUTION AVERAGING.
C
      IF(IOPT.LT.2.OR.LENCON.LT.(NN+1))GO TO 40
C
C
C  CONVOLUTION AVERAGING.
C
C
C
C  CALCULATE AND OUTPUT THE NUMBER OF DEGREES OF FREEDOM AND THE COR-
C  RESPONDING SIGNIFICANCE LEVEL.
C
      NDOF=2*(2*NN+1)*LENGTH/LTRANS
      SIGLVL=SL(NDOF)
      WRITE(OUT,3001)NN,NDOF,SIGLVL
C
C  INITIALIZE VARIABLES ASSOCIATED WITH CONVOLUTION AVERAGING.
C
      INPUT=1
      NUMB=IASIZE-2*NN
      P=0.
      F=0.
      LENG=IASIZE
      IF(IASIZE.GT.(LENCON+NN))LENG=LENCON+NN
      K=NN+1
C
C  NOW FILL THE 'U' ARRAYS WITH UNAVERAGED VALUES. ESTIMATES MUST BE
C  'FOLDED' AROUND THE ZERO FREQUENCY ESTIMATE.
C
      DO 11 I=K,LENG
         CALL CALC(INPUT,I,STEP,LENGTH,NINPUT,PSTCLR,NWINDO)
         INPUT=INPUT+1
 11      CONTINUE
      NNX2=NN*2
      DO 12 I=1,NN
         J=NNX2+2-I
         CALL SWAP(I,J)
 12      CONTINUE
C
C  IF THE 'U' ARRAYS ARE NOT FULL SKIP THE SECTION AVERAGING FULL
C  ARRAYS.
C
      IF(IASIZE.GT.(LENCON+NN))GO TO 52
      NTA=1+(LENCON-(IASIZE-NN))/(IASIZE-NNX2)
C
C  THIS LOOP AVERAGES FULL ARRAYS,OUTPUTS PHASE AND COHERENCE DATA,
C  MOVES VALUES TO THE TOPS OF ARRAYS,AND REFILLS THE REMAINDERS OF
C  THE ARRAYS.
C
      DO 19 K=1,NTA
      CALL AVRG(IASIZE,NN,NSTORE)
```

```
C
C  THIS LOOP OUTPUTS THE AVERAGED PHASE AND COHERENCE VALUES ALONG
C  WITH THE ASSOCIATED PERIODS AND FREQUENCIES.
C
      DO 16 I=1,NUMB
         NOUT=NOUT+1
         CALL PHACOH(I)
         WRITE(OUT,1003)NOUT,F,P,COABPP,PHABPP,COABNN,PHABNN,COABPN,
     *                 PHABPN,COABNP,PHABNP
         IF(F.NE.0.)WRITE(OUTPLT,7001)F,COABPP,PHABPP,COABNN,PHABNN,
     *                                 COABPN,PHABPN,COABNP,PHABNP
 7001    FORMAT(9A6)
 1003    FORMAT(' ',I5,F9.5,F10.2,4(F9.2,F11.4))
         IF(NOUT/60*60.EQ.NOUT)WRITE(OUT,1004)
 1004    FORMAT('1'///)
         P=PERIOD/FLOAT(NOUT)
         F=1./P
   16    CONTINUE
C
C  NOW MOVE THE LAST 2*NN ELEMENTS TO THE TOPS OF THE U ARRAYS.
C
      J=IASIZE-NNX2
      DO 17 I=1,NNX2
         J=J+1
         CALL SWAP(I,J)
   17    CONTINUE
C
C  REFILL THE 'U' ARRAYS UNLESS GOING THROUGH THE LOOP FOR THE LAST TIME
C
      IF(K.EQ.NTA)GO TO 19
      L=NNX2+1
      DO 18 I=L,IASIZE
         CALL CALC(INPUT,I,STEP,LENGTH,NINPUT,PSTCLR,NWINDO)
         INPUT=INPUT+1
   18    CONTINUE
   19 CONTINUE
C
C  IF NECESSARY,PLACE REMAINING VALUES IN THE 'U' ARRAYS.
C
      LEFT=LENCON-(INPUT-1)
      LENG=NNX2+LEFT
      IF(LEFT.LT.1)GO TO 52
      J=NNX2+1
      DO 51 I=J,LENG
         CALL CALC(INPUT,I,STEP,LENGTH,NINPUT,PSTCLR,NWINDO)
         INPUT=INPUT+1
   51    CONTINUE
C
C  IF NO NEED TO 'FOLD' AROUND THE LAST ESTIMATE SKIP THE NEXT SECTION.
C
   52 IF(IOPT.GT.2.OR.NN.EQ.0)GO TO 55
      J=LENG+NN
      IF(J.GT.IASIZE)J=IASIZE
```

RCSPEC (CONT'D.)

```
      I=LENG+1
      LENG=LENG+NN
C
C   'FOLD' AROUND THE LAST ESTIMATE UNLESS THERE ISN'T ENOUGH ROOM IN
C   THE 'U' ARRAYS TO DO SO.
C
      IF(I.GT.IASIZE)GO TO 59
      L=I
      K=I-1
      DO 54 I=L,J
         K=K-1
         CALL SWAP(I,K)
   54    CONTINUE
C
C   IF THE 'U' ARRAYS ARE NOT FULL SKIP TO SECTION FOR HANDLING THEM.
C   OTHERWISE, AVERAGE THE ESTIMATES AND OUTPUT THE PHASE AND COHE-
C   RENCE DATA ALONG WITH THE ASSOCIATED PERIODS AND FREQUENCIES.
C
      IF(LENG.LE.IASIZE)GO TO 55
   59 CALL AVRG(IASIZE,NN,NSTORE)
      DO 56 I=1,NUMB
         NOUT=NOUT+1
         CALL PHACOH(I)
         WRITE(OUT,1003)NOUT,F,P,COABPP,PHABPP,COABNN,PHABNN,COABPN,
     *                   PHABPN,COABNP,PHABNP
         IF(F.NE.0.)WRITE(OUTPLT,7001)F,COABPP,PHABPP,COABNN,PHABNN,
     *                                  COABPN,PHABPN,COABNP,PHABNP
         IF(NOUT/60*60.EQ.NOUT)WRITE(OUT,1004)
         P=PERIOD/FLOAT(NOUT)
         F=1./P
   56    CONTINUE
C
C   NOW MOVE THE LAST 2*NN VALUES TO THE TOP OF THE 'U' ARRAYS AND
C   'FOLD' AROUND THE LAST ESTIMATE.
C
      J=IASIZE-NNX2
      DO 57 I=1,NNX2
         J=J+1
         CALL SWAP(I,J)
   57    CONTINUE
      LENG=LENG-IASIZE+NNX2
      L=LENG-NNX2
      J=L+LENG-NNX2-1
      K=LENG+1
      DO 58 I=L,J
         K=K-1
         CALL SWAP(K,I)
   58    CONTINUE
C
C   THIS SECTION IS FOR HANDLING SITUATIONS WHEN THE 'U' ARRAYS ARE
C   NOT FULL. FIRST,THE ESTIMATES ARE AVERAGED. THEN THE AVERAGED
C   PHASE AND COHERENCE VALUES ARE OUTPUT.
C
```

```
   55 IF(LENG.EQ.0)GO TO 60
      CALL AVRG(LENG,NN,NSTORE)
      NUMB=LENG-2*NN
      DO 53 I=1,NUMB
         NOUT=NOUT+1
         CALL PHACOH(I)
         WRITE(OUT,1003)NOUT,F,P,COABPP,PHABPP,COABNN,PHABNN,COABPN,
     *                  PHABPN,COABNP,PHABNP
         IF(F.NE.0.)WRITE(OUTPLT,7001)F,COABPP,PHABPP,COABNN,PHABNN,
     *                                COABPN,PHABPN,COABNP,PHABNP
         IF(NOUT/60*60.EQ.NOUT)WRITE(OUT,1004)
         P=PERIOD/FLOAT(NOUT)
         F=1./P
   53    CONTINUE
C
C  UNLESS BLOCK AVERAGING IS TO BE PERFORMED,OUTPUT CO- AND QUAD-
C  SPECTRAL ESTIMATES WHICH ARE NOW STORED IN THE INPUT ARRAYS.
C
   60 IF(IOPT.GT.2)GO TO 40
      WRITE(OUT,1007)
 1007 FORMAT('1',2X,'INDEX  FREQ',4X,'PERIOD',2X,4(3X,'COSPEC',3X,
     *       'QUADSPEC')/' ',10X,'CPH',5X,'HOURS',7X,'++',8X,'++',8X,
     *       '--',8X,'--',8X,'+-',8X,'+-',8X,'-+',8X,'-+'/)
      WRITE(OUT,3002)NN,NDOF
      P=0.
      F=0.
      DO 20 I=1,LENCON
         WRITE(OUT,1005)I,F,P,AU(I),AV(I),BU(I),BV(I)
 1005    FORMAT(' ',I5,F9.5,F9.2,2X,8F10.2)
         IF(I/60*60.EQ.I)WRITE(OUT,1004)
         P=PERIOD/FLOAT(I)
         F=1./P
   20    CONTINUE
      STOP
C
C
C  BLOCK AVERAGING.
C
C
   40 LENCON=LENCON-NN
      ISTART(NUMBNN+1)=NINPUT
C
C  PERFORM BLOCK AVERAGING USING NUMBNN BLOCK SIZES.
C
      DO 33 K=1,NUMBNN
C
C  CALCULATE VALUES BASED ON THE SIZE OF THE AVERAGING INTERVAL. ALSO,
C  DETERMINE THE NUMBER OF DEGREES OF FREEDOM AND ITS ASSOCIATED
C  SIGNIFICANCE LEVEL AND OUTPUT THEM.
C
      NN=NNS(K)
      LENGAV=2*NN+1
      INPUT=ISTART(K)
      NBLOCK=(ISTART(K+1)-ISTART(K))/LENGAV
      NBLPRA=IASIZE/LENGAV
      NTA=NBLOCK/NBLPRA
      NDOF=2*(2*NN+1)*LENGTH/LTRANS
      SIGLVL=SL(NDOF)
      WRITE(OUT,3001)NN,NDOF,SIGLVL
 3001 FORMAT(' ',6X,'***** NN=',I2,' *****',6X,'DEGREES OF FREEDOM=',I3,
     *       6X,'SIGNIFICANCE LEVEL=',F6.2)
      I=1
      IF(NTA.EQ.0) GO TO 34
      LARRAY=NBLPRA*LENGAV
C
C  THIS LOOP FILLS THE 'U' ARRAYS,AVERAGES THE ESTIMATES,AND OUTPUTS
C  THE PHASE AND COHERENCE DATA.
C
      DO 24 I=1,NTA
C
C  THIS LOOP FILLS THE 'U' ARRAYS COMPLETELY.
C
         DO 25 J=1,LARRAY
            CALL CALC(INPUT,J,STEP,LENGTH,NINPUT,PSTCLR,NWINDO)
            INPUT=INPUT+1
   25       CONTINUE
         CALL BAVRG(NBLPRA,NN,NSTORE)
C
C  NOW OUTPUT THE PHASE AND COHERENCE VALUES WITH THE ASSOCIATED PERIODS
C  AND FREQUENCIES.
C
         DO 26 J=1,NBLPRA
            NOUT=NOUT+1
            CALL PHACOH(J)
            P=PERIOD/FLOAT(ISTART(K)+(I-1)*LARRAY+(J-1)*LENGAV+NN-1)
            F=1./P
            WRITE(OUT,1003)NOUT,F,P,COABPP,PHABPP,COABNN,PHABNN,COABPN,
     *                    PHABPN,COABNP,PHABNP
            WRITE(OUTPLT,7001)F,COABPP,PHABPP,COABNN,PHABNN,COABPN,
     *                       PHABPN,COABNP,PHABNP
            IF(NOUT/60*60.EQ.NOUT)WRITE(OUT,1004)
   26       CONTINUE
   24    CONTINUE
C
C  THIS SECTION IS FOR THE SITUATION WHEN THE 'U' ARRAYS CANNOT BE
C  COMPLETELY FILLED.
C
      I=NTA+1
   34 NBLPRA=NBLOCK-NTA*NBLPRA
      IF(NBLPRA.EQ.0)GO TO 33
C
C  FILL AS MUCH OF THE 'U' ARRAYS AS POSSIBLE USING THE REMAINDER OF
C  THE INPUT VALUES.
C
      LARRAY=NBLPRA*LENGAV
```

RCSPEC (CONT'D.)

```
      DO 31  J=1,LARRAY
         CALL CALC(INPUT,J,STEP,LENGTH,NINPUT,PSTCLR,NWINDO)
         INPUT=INPUT+1
   31    CONTINUE
C
C  AVERAGE THE ESTIMATES IN THE 'U' ARRAYS AND OUTPUT THE PHASE AND
C  COHERENCE VALUES.
C
      CALL BAVRG(NBLPRA,NN,NSTORE)
      LARRAY=IASIZE/LENGAV*LENGAV
      DO 32  J=1,NBLPRA
         NOUT=NOUT+1
         CALL PHACOH(J)
         P=PERIOD/FLOAT(ISTART(K)+(I-1)*LARRAY+(J-1)*LENGAV+NN-1)
         F=1./P
         WRITE(OUT,1003)NOUT,F,P,COABPP,PHABPP,COABNN,PHABNN,COABPN,
     *                  PHABPN,COABNP,PHABNP
         WRITE(OUTPLT,7001)F,COABPP,PHABPP,COABNN,PHABNN,COABPN,PHABPN,
     *                  COABNP,PHABNP
         IF(NOUT/60*60.EQ.NOUT)WRITE(OUT,1004)
   32    CONTINUE
   33 CONTINUE
C
C  THIS SECTION OUTPUTS THE CO- AND QUAD- SOECTRAL ESTIMATES. FIRST
C  PRINT THE HEADING.
C
      WRITE(OUT,1007)
      NOUT=0
C
C  IF CONVOLUTION AVERAGING WAS NOT PERFORMED,SKIP THIS SECTION.
C  OTHERWISE,CALCULATE AND OUTPUT THE NUMBER OF DEGREES OF FREEDOM
C  AND OUTPUT THE CO- AND QUAD- SPECTRAL ESTIMATES.
C
      IF(IOPT.LT.2.OR.LENCON.LT.1)GO TO 36
      NDOF=2*(NNX2+1)*LENGTH/LTRANS
      WRITE(OUT,3002)NN,NDOF
      P=0.0
      F=0.0
      DO 37  I=1,LENCON
         WRITE(OUT,1005)I,F,P,AU(I),AV(I),BU(I),BV(I)
         IF(I/60*60.EQ.I)WRITE(OUT,1004)
         P=PERIOD/FLOAT(I)
         F=1./P
   37    CONTINUE
      NOUT=LENCON
C
C  THIS LOOP OUTPUTS CO- AND QUAD- SPECTRAL ESTIMATES FOR VALUES
C  THAT HAVE BEEN BLOCK AVERAGED. FIRST,THE NUMBER OF DEGREES OF
C  FREEDOM CORRESPONDING TO EACH NN VALUE IS CALCULATED AND OUTPUT.
C  THEN,THE SPECTRAL ESTIMATES ARE PRINTED.
C
```

RCSPEC (CONT'D.)

```
   36 DO 35 K=1,NUMBNN
        NN=NNS(K)
        LENGAV=2*NN+1
        NDOF=2*LENGAV*LENGTH/LTRANS
        WRITE(OUT,3002)NN,NDOF
        NBLOCK=(ISTART(K+1)-ISTART(K))/LENGAV
        DO 30 I=1,NBLOCK
           NOUT=NOUT+1
           P=PERIOD/FLOAT(ISTART(K)+(I-1)*LENGAV+NN-1)
           F=1./P
           WRITE(OUT,1005)NOUT,F,P,AU(NOUT),AV(NOUT),BU(NOUT),BV(NOUT)
           IF(NOUT/60*60.EQ.NOUT)WRITE(OUT,1004)
   30      CONTINUE
   35   CONTINUE
     STOP
 3002 FORMAT(6X,'***NN=',I3,'  ***',6X,'DEGREES OF FREEDOM=',I3)
     END
```

IV. B.1 CALC

```
      SUBROUTINE CALC(INPUT,I,STEP,LENGTH,NINPUT,PSTCLR,NWINDO)
C  THIS SUBROUTINE CALCULATES ONE VALUE IN EACH OF THE 'U' ARRAYS
C  GIVEN ONE VALUE FROM EACH OF THE INPUT ARRAYS. THE 'U' ARRAYS ARE
C  PRODUCTS OF CLOCKWISE AND/OR ANTICLOCKWISE COMPLEX FOURIER COEF-
C  FICIENTS AT LOCATIONS A AND/OR B. IF THE USER DESIRES THEM,POST-
C  COLORING AND/OR SPECTRAL WINDOW SCALING ARE IMPLEMENTED IN THIS
C  ROUTINE.
C
C
C      VARIABLE LIST
C
C  INPUT              THE POSITION IN THE INPUT ARRAYS OF THE FOURIER
C                     COEFFICIENTS TO USE TO CALCULATE THE VALUES FOR THE
C                     'U' ARRAYS.
C  I                  THE POSITION IN THE 'U' ARRAYS TO STORE THE CALCULATED
C                     VALUES.
C  STEP               THE TIME INCREMENT(IN HOURS) BETWEEN THE TIME SERIES
C                     ESTIMATES.
C  LENGTH             THE NUMBER OF POINTS IN THE ORIGINAL TIME SERIES.
C  NINPUT             THE NUMBER OF FOURIER COEFFICIENTS INPUT.
C  PSTCLR             DETERMINES IF DATA SHOULD BE POST-COLORED OR NOT:
C                          0  DO NOT POST-COLOR.
C                          1  POST COLOR.
C  NWINDO             DENOTES THE TYPE OF SPECTRAL WINDOW USED WHEN COMPUTING
C                     FOURIER COEFFICIENTS AND IF SPECTRAL WINDOW SCALING
C                     SHOULD BE PERFORMED.
C                          0  BOXCAR(NO) WINDOW.
C                          1  10% COSINE WINDOW.
C                          2  HANNING WINDOW.
C                          3  HAMMING WINDOW.
C                          4  PARZEN WINDOW.
C                          5  LANCZOS WINDOW.
C                     IF THE VALUE OF NWINDO IS GREATER THAN 10,THEN SPECTRAL
C                     WINDOW SCALING SHOULD BE PERFORMED USING SPECTRAL
C                     WINDOW NWINDO-10.
C  PI                 SELF EXPLANATORY.
C  FACTOR             MULTIPLICATIVE SCALING FACTOR. INITIALLY EQUAL TO
C                     STEP/LENGTH BUT MAY BE CHANGED BY POST-COLORING AND/OR
C                     SPECTRAL WINDOW SCALING.
C  UAPOS              ANTICLOCKWISE COMPLEX FOURIER COEFFICIENT AT LOCATION
C                     A. UANEG,UBPOS,UBNEG,UAPOSC(CONJUGATE OF UAPOS),UANEGC
C                     ARE OTHER VARIABLES LIKE THIS AT DIFFERING LOCATIONS
C                     AND/OR ROTATIONS.
C  'U' ARRAYS         PRODUCTS OF ANTICLOCKWISE AND/OR CLOCKWISE COMPLEX
C                     FOURIER COEFFICIENTS AT LOCATIONS A AND/OF B. ALL CAL-
C                     CULATED VALUES FROM THIS PROGRAM ARE DERIVED FROM
C                     THESE ARRAYS.
C  N                  POINTER.
```

CALC (CONT'D.)

```
C   AU,AV,BU,BV   ARRAYS CONTAINING COMPLEX FOURIER COEFFICIENTS.
C
      COMPLEX AU(4097),AV(4097),BU(4097),BV(4097),
     *        UACPBP(50),UACNBN(50),UACPBN(50),UACNBP(50),
     *        UACPAP(50),UBCPBP(50),UACNAN(50),UBCNBN(50)
      COMPLEX UAPOS,UANEG,UBPOS,UBNEG,UAPOSC,UANEGC
      INTEGER PSTCLR
      COMMON AU,AV,BU,BV,UACPBP,UACNBN,UACPBN,UACNBP,UACPAP,UBCPBP,
     *     UACNAN,UBCNBN
      PI=3.1415927
      FACTOR=STEP/FLOAT(LENGTH)
C
C   DETERMINE IF POST-COLORING SHOULD BE IMPLEMENTED. IF SO,MODIFY THE
C   VALUE OF FACTOR TO REFLECT THIS.
C
      IF(PSTCLR.NE.1)GO TO 10
C
C   TEST FOR POSSIBLE DIVIDE CHECK PROBLEMS. IF FOUND,DIVIDE FACTOR
C   BY A DEFAULT VALUE.
C
        IF(INPUT.NE.1.AND.(PI*FLOAT(INPUT-1)/(FLOAT(NINPUT-1)*2.))
     *            .NE.0)GO TO 12
          FACTOR=FACTOR/.000001
          GO TO 10
   12   FACTOR=FACTOR/(4.*SIN(PI*FLOAT(INPUT-1)/
     *          (FLOAT(NINPUT-1)*2.))**2)
C
C   DETERMINE IF SPECTRAL WINDOW SCALING SHOULD BE IMPLEMENTED. IF SO,
C   MODIFY THE VALUE OF FACTOR TO REFLECT THIS.
C
    10 IF(NWINDO.LT.11)GO TO 11
        N=NWINDO-10
        GO TO (1,2,3,4,5),N
     1  FACTOR=FACTOR/.873239
        GO TO 11
     2  FACTOR=FACTOR/.374245
        GO TO 11
     3  FACTOR=FACTOR/.396612
        GO TO 11
     4  FACTOR=FACTOR/.269099
        GO TO 11
     5  FACTOR=FACTOR/.450503
C
C   COMPUTE THE ANTICLOCKWISE AND CLOCKWISE FOURIER COEFFICIENTS AT
C   LOCATIONS A AND B AND THEIR CONJUGATES.
C
    11 UAPOS=AU(INPUT)+(0.,1.)*AV(INPUT)
      UANEG=AU(INPUT)-(0.,1.)*AV(INPUT)
      UBPOS=BU(INPUT)+(0.,1.)*BV(INPUT)
      UBNEG=BU(INPUT)-(0.,1.)*BV(INPUT)
      UAPOSC=CONJG(UAPOS)
      UANEGC=CONJG(UANEG)
```

```
C
C  COMPUTE VALUES FOR THE 'U' ARRAYS.
C
      UACPBP(I)=UAPOSC*UBPOS*FACTOR
      UACNBN(I)=UANEGC*UBNEG*FACTOR
      UACPBN(I)=UAPOSC*UBNEG*FACTOR
      UACNBP(I)=UANEGC*UBPOS*FACTOR
      UACPAP(I)=UAPOSC*UAPOS*FACTOR
      UBCPBP(I)=CONJG(UBPOS)*UBPOS*FACTOR
      UACNAN(I)=UANEGC*UANEG*FACTOR
      UBCNBN(I)=CONJG(UBNEG)*UBNEG*FACTOR
      RETURN
      END
```

IV. B.2 SWAP

```
      SUBROUTINE SWAP(I,J)
C
C  THIS SUBROUTINE MOVES VALUES IN THE 'U' ARRAYS AT POSITION J TO
C  POSITION I.
C
C
C       VARIABLE LIST
C
C  J              LOCATION OF VALUES IN THE 'U' ARRAYS TO BE MOVED.
C  I              LOCATION IN THE 'U' ARRAYS WHERE VALUES ARE MOVED TO.
C
      COMPLEX AU(4097),AV(4097),BU(4097),BV(4097),
     *        UACPBP(50),UACNBN(50),UACPBN(50),UACNBP(50),
     *        UACPAP(50),UBCPBP(50),UACNAN(50),UBCNBN(50)
      COMMON AU,AV,BU,BV,UACPBP,UACNBN,UACPBN,UACNBP,UACPAP,UBCPBP,
     *       UACNAN,UBCNBN
         UACPBP(I)=UACPBP(J)
         UACNBN(I)=UACNBN(J)
         UACPBN(I)=UACPBN(J)
         UACNBP(I)=UACNBP(J)
         UACPAP(I)=UACPAP(J)
         UBCPBP(I)=UBCPBP(J)
         UACNAN(I)=UACNAN(J)
         UBCNBN(I)=UBCNBN(J)
      RETURN
      END
```

IV. B.3 AVRG

```
      SUBROUTINE AVRG(LENG,NN,NSTORE)
C
C  THIS SUBROUTINE PERFORMS CONVOLUTION(RUNNING) AVERAGING ON THE 'U'
C  ARRAYS. THE AVERAGED ESTIMATES ARE STORED AT THE 'TOP' OF THE 'U'
C  ARRAYS. THE CO- AND QUAD- SPECTRAL ESTIMATES ARE STORED IN THE INPUT
C  ARRAYS(AU,AV,BU,BV).
C
C
C      VARIABLE LIST
C
C  LENG             THE NUMBER OF ESTIMATES IN THE 'U' ARRAYS TO BE IN-
C                   VOLVED IN AVERAGING.
C  NN               THE NUMBER OF ADJACENT FREQUENCY BANDS TO AVERAGE
C                   OVER.
C  NSTORE           THE NEXT POSITION IN THE INPUT ARRAYS TO BE FILLED WITH
C                   CO- AND QUAD- SPECTRAL ESTIMATES.
C  NAVRG            THE ACTUAL NUMBER OF ESTIMATES TO AVERAGE OVER.
C  RAVRG            SAME AS NAVRG BUT REAL.
C  NUMB             THE NUMBER OF AVERAGED ESTIMATES TO BE CALCULATED.
C  NUMBM1           NUMB(ABOVE)-1.
C  SUM1-SUM8        RUNNING SUMS OF NAVRG ESTIMATES IN THE 'U' ARRAYS.
C  A1-A8            TEMPORARY VARIABLES USED TO SAVE ESTIMATES.
C  AU,AV,BU,BV      INPUT ARRAYS(ALSO USED TO STORE CO- AND QUAD- SPECTRAL
C                   ESTIMATES).
C  I,N              INDEXES.
C  'U' ARRAYS       PRODUCTS OF ANTICLOCKWISE AND/OR CLOCKWISE COMPLEX
C                   FOURIER COEFFICIENTS AT LOCATIONS A AND/OR B. THESE
C                   ARE THE VALUES THAT ARE AVERAGED IN THIS SUBROUTINE.
C
      COMPLEX AU(4097),AV(4097),BU(4097),BY(4097),
     *        UACPBP(50),UACNBN(50),UACPBN(50),UACNBP(50),
     *        UACPAP(50),UBCPBP(50),UACNAN(50),UBCNBN(50),
     *        SUM1,SUM2,SUM3,SUM4,SUM5,SUM6,SUM7,SUM8,
     *        A1,A2,A3,A4,A5,A6,A7,A8
      COMMON AU,AV,BU,BV,UACPBP,UACNBN,UACPBN,UACNBP,UACPAP,UBCPBP,
     *      UACNAN,UBCNBN
C
C  INITIALIZE VARIABLES.
C
      NAVRG=2*NN+1
      NUMB=LENG-2*NN
      RAVRG=FLOAT(NAVRG)
      NUMBM1=NUMB-1
      SUM1=CMPLX(0.,0.)
      SUM2=CMPLX(0.,0.)
      SUM3=CMPLX(0.,0.)
      SUM4=CMPLX(0.,0.)
      SUM5=CMPLX(0.,0.)
      SUM6=CMPLX(0.,0.)
      SUM7=CMPLX(0.,0.)
      SUM8=CMPLX(0.,0.)
C
C   SUM FIRST NAVRG ESTIMATES.
C
      DO 14 J=1,NAVRG
         SUM1=SUM1+UACPBP(J)
         SUM2=SUM2+UACNBN(J)
         SUM3=SUM3+UACPBN(J)
         SUM4=SUM4+UACNBP(J)
         SUM5=SUM5+UACPAP(J)
         SUM6=SUM6+UBCPBP(J)
         SUM7=SUM7+UACNAN(J)
         SUM8=SUM8+UBCNBN(J)
   14    CONTINUE
      IF(NUMBM1.LT.1)GO TO 16
C
C   CALCULATE NUMBM1 AVERAGED ESTIMATES.
C
      DO 15 I=1,NUMBM1
C
C   SAVE ESTIMATES FOR LATER.
C
         A1=UACPBP(I)
         A2=UACNBN(I)
         A3=UACPBN(I)
         A4=UACNBP(I)
         A5=UACPAP(I)
         A6=UBCPBP(I)
         A7=UACNAN(I)
         A8=UBCNBN(I)
C
C   DIVIDE SUMS BY RAVRG TO CALCULATE AVERAGES AND STORE IN THE 'U'
C   ARRAYS.
C
         UACPBP(I)=SUM1/RAVRG
         UACNBN(I)=SUM2/RAVRG
         UACPBN(I)=SUM3/RAVRG
         UACNBP(I)=SUM4/RAVRG
         UACPAP(I)=SUM5/RAVRG
         UBCPBP(I)=SUM6/RAVRG
         UACNAN(I)=SUM7/RAVRG
         UBCNBN(I)=SUM8/RAVRG
C
C   STORE CO- AND QUAD- SPECTRAL ESTIMATES IN THE INPUT ARRAYS.
C
         AU(NSTORE)=UACPBP(I)
         AV(NSTORE)=UACNBN(I)
         BU(NSTORE)=UACPBN(I)
         BV(NSTORE)=UACNBP(I)
         NSTORE=NSTORE+1
```

AVRG (CONT'D.)

```
C
C DETERMINE SUMS FOR NEXT ESTIMATES.
C
      SUM1=SUM1-A1+UACPBP(I+NAVRG)
      SUM2=SUM2-A2+UACNBN(I+NAVRG)
      SUM3=SUM3-A3+UACPBN(I+NAVRG)
      SUM4=SUM4-A4+UACNBP(I+NAVRG)
      SUM5=SUM5-A5+UACPAP(I+NAVRG)
      SUM6=SUM6-A6+UBCPBP(I+NAVRG)
      SUM7=SUM7-A7+UACNAN(I+NAVRG)
      SUM8=SUM8-A8+UBCNBN(I+NAVRG)
  15  CONTINUE
C
C DIVIDE SUMS BY RAVRG TO CALCULATE AVERAGES FOR FINAL ESTIMATES IN
C THE 'U' ARRAYS.
C
  16 UACPBP(NUMB)=SUM1/RAVRG
     UACNBN(NUMB)=SUM2/RAVRG
     UACPBN(NUMB)=SUM3/RAVRG
     UACNBP(NUMB)=SUM4/RAVRG
     UACPAP(NUMB)=SUM5/RAVRG
     UBCPBP(NUMB)=SUM6/RAVRG
     UACNAN(NUMB)=SUM7/RAVRG
     UBCNBN(NUMB)=SUM8/RAVRG
C
C STORE CO- AND QUAD- SPECTRAL ESTIMATES IN THE 'U' ARRAYS.
C
     AU(NSTORE)=UACPBP(NUMB)
     AV(NSTORE)=UACNBN(NUMB)
     BU(NSTORE)=UACPBN(NUMB)
     BV(NSTORE)=UACNBP(NUMB)
     NSTORE=NSTORE+1
     RETURN
     END
```

IV. B.4 BAVRG

```
      SUBROUTINE BAVRG(NUMBL,NN,NSTORE)
C
C  THIS SUBROUTINE PERFORMS BLOCK AVERAGING ON THE 'U' ARRAYS. AS
C  EACH BLOCK OF 2*NN+1 ELEMENTS IS AVERAGED,THE NEW VALUES ARE MOVED
C  TO THE TOP OF THE 'U' ARRAYS. THE CO- AND QUAD- SPECTRAL ESTIMATES
C  ARE STORED IN THE INPUT ARRAYS(AU,AV,BU,BV).
C
C
C      VARIABLE LIST
C
C  NUMBL          THE NUMBER OF BLOCKS TO BE AVERAGED.
C  NN             THE NUMBER OF ADJACENT FREQUENCY BANDS TO AVERAGE OVER.
C  NSTORE         THE NEXT POSITION IN THE INPUT ARRAYS TO BE FILLED WITH
C                 CO- AND QUAD- SPECTRAL ESTIMATES.
C  NAVRG          THE ACTUAL NUMBER OF POINTS PER BLOCK TO AVERAGE.
C  AVRG           SAME AS NAVRG BUT REAL.
C  SUM1-SUM8      RUNNING SUMS OF THE ESTIMATES PER BLOCK OF THE 'U'
C                 ARRAYS.
C  I,J,K          INDEXES.
C  AU,AV,BU,BV    INPUT ARRAYS(ALSO USED TO STORE CO- AND QUAD- SPECTRAL
C                 ESTIMATES).
C  'U' ARRAYS     PRODUCTS OF ANTICLOCKWISE AND/OR CLOCKWISE COMPLEX
C                 FOURIER COEFFICIENTS AT LOCATIONS A AND/OR B. THESE
C                 ARE THE VALUES THAT ARE AVERAGED IN THIS SUBROUTINE.
C
      COMPLEX AU(4097),AV(4097),BU(4097),BV(4097),
     *        UACPBP(50),UACNBN(50),UACPBN(50),UACNBP(50),
     *        UACPAP(50),UBCPBP(50),UACNAN(50),UBCNBN(50),
     *        SUM1,SUM2,SUM3,SUM4,SUM5,SUM6,SUM7,SUM8
      COMMON AU,AV,BU,BV,UACPBP,UACNBN,UACPBN,UACNBP,UACPAP,UBCPBP,
     *       UACNAN,UBCNBN
      NAVRG=2*NN+1
      AVRG=FLOAT(NAVRG)
C
C  AVERAGE NUMBL BLOCKS.
C
      DO 10 I=1,NUMBL
C
C  INITIALIZE SUMS TO ZERO.
C
         SUM1=CMPLX(0.,0.)
         SUM2=CMPLX(0.,0.)
         SUM3=CMPLX(0.,0.)
         SUM4=CMPLX(0.,0.)
         SUM5=CMPLX(0.,0.)
         SUM6=CMPLX(0.,0.)
         SUM7=CMPLX(0.,0.)
         SUM8=CMPLX(0.,0.)
C
C  SUM NAVRG ESTIMATES.
C
         DO 11 J=1,NAVRG
            K=(I-1)*NAVRG+J
```

BAVRG (CONT'D.)

```
            SUM1=SUM1+UACPBP(K)
            SUM2=SUM2+UACNBN(K)
            SUM3=SUM3+UACPBN(K)
            SUM4=SUM4+UACNBP(K)
            SUM5=SUM5+UACPAP(K)
            SUM6=SUM6+UBCPBP(K)
            SUM7=SUM7+UACNAN(K)
   11       SUM8=SUM8+UBCNBN(K)
C
C  DIVIDE BY AVRG TO CALCULATE AVERAGES AND STORE IN 'U' ARRAYS.
C
         UACPBP(I)=SUM1/AVRG
         UACNBN(I)=SUM2/AVRG
         UACPBN(I)=SUM3/AVRG
         UACNBP(I)=SUM4/AVRG
         UACPAP(I)=SUM5/AVRG
         UBCPBP(I)=SUM6/AVRG
         UACNAN(I)=SUM7/AVRG
         UBCNBN(I)=SUM8/AVRG
C
C  STORE CO- AND QUAD- SPECTRAL ESTIMATES IN THE INPUT ARRAYS.
C
         AU(NSTORE)=UACPBP(I)
         AV(NSTORE)=UACNBN(I)
         BU(NSTORE)=UACPBN(I)
         BV(NSTORE)=UACNBP(I)
   10    NSTORE=NSTORE+1
      RETURN
      END
```

IV. B.5 PHACOH

```
      SUBROUTINE PHACOH(I)
C
C     THIS SUBROUTINE CALCULATES THE SQUARED COHERENCIES AND PHASES BE-
C     TWEEN THE PAIRS OF POLARIZED CONSTITUENTS AT LOCATIONS A*B GIVEN A
C     PARTICULAR LOCATION IN THE 'U' ARRAYS. FIRST,COMPLEX CROSS SPECTRAL
C     ESTIMATES FOR THE PAIRS OF POLARIZED CONSTITUENTS AT DIFFERENT
C     LOCATIONS ARE CALCULATED. THEN,THE SQUARED COHERENCIES AND PHASES
C     ARE EASILY CALCULATED FROM THE REAL AND IMAGINARY COMPONENTS OF
C     THESE ESTIMATES.
C
C
C         VARIABLE LIST
C
C     I              THE POSITION OF THE VALUES IN THE 'U' ARRAYS FOR WHICH
C                    SQUARED COHERENCIES AND PHASES ARE CALCULATED.
C     GABPP,GABNN,   CROSS SPECTRAL ESTIMATES FOR PAIRS OF POLARIZED CON-
C     GABPN,GABNP    STITUENTS AT LOCATIONS A AND B.
C     RABPP,RABNN,   THE REAL COMPONENTS OF THE COMPLEX CROSS SPECTRAL
C     RABNP,RABPN    ESTIMATES.
C     AIABPP,AIABNN, THE IMAGINARY COMPONENTS OF THE COMPLEX CROSS SPECTRAL
C     AIABNP,AIABPN  ESTIMATES.
C     COABPP,COABNN, THE SQUARED COHERENCIES BETWEEN THE PAIRS OF POLA-
C     COABNP,COABPN  RIZED CONSTITUENTS AT LOCATIONS A AND B.
C     PHABPP,PHABNN, THE PHASES FOR THE PAIRS OF POLARIZED CONSTITUENTS
C     PHABNP,PHABPN  AT LOCATIONS A AND B.
C     'U' ARRAYS     THE PRODUCTS OF ANTICLOCKWISE AND/OR CLOCKWISE COMPLEX
C                    FOURIER COEFFICIENTS AT LOCATIONS A AND/OR B.
C
      COMPLEX AU(4097),AV(4097),BU(4097),BV(4097),
     *        UACPBP(50),UACNBN(50),UACPBN(50),UACNBP(50),
     *        UACPAP(50),UBCPBP(50),UACNAN(50),UBCNBN(50),
     *        GABPP,GABNN,GABPN,GABNP
      COMMON AU,AV,BU,BV,UACPBP,UACNBN,UACPBN,UACNBP,UACPAP,UBCPBP,
     *       UACNAN,UBCNBN,
     *       PHABPP,PHABNN,PHABPN,PHABNP,COABPP,COABNN,COABPN,COABNP
C
C     CALCULATE THE CROSS SPECTRAL ESTIMATES FOR THE PAIRS OF POLARIZED
C     CONSTITUENTS AT LOCATIONS A AND B.
C
      RAD=180./3.1415927
      GABPP=UACPBP(I)/CSQRT(UACPAP(I)*UBCPBP(I))
      GABNN=UACNBN(I)/CSQRT(UACNAN(I)*UBCNBN(I))
      GABPN=UACPBN(I)/CSQRT(UACPAP(I)*UBCNBN(I))
      GABNP=UACNBP(I)/CSQRT(UBCPBP(I)*UACNAN(I))
C
C     BREAK THE COMPLEX CROSS SPECTRAL ESTIMATES INTO THEIR REAL AND
C     IMAGINARY COMPONENTS.
C
```

PHACOH (CONT'D.)

```
      RABPP=REAL(GABPP)
      AIABPP=AIMAG(GABPP)
      RABNN=REAL(GABNN)
      AIABNN=AIMAG(GABNN)
      RABPN=REAL(GABPN)
      AIABPN=AIMAG(GABPN)
      RABNP=REAL(GABNP)
      AIABNP=AIMAG(GABNP)
C
C  CALCULATE THE SQUARED COHERENCIES AND PHASES.
C
      PHABPP=ATAN2(AIABPP,RABPP)*RAD
      COABPP=RABPP**2+AIABPP**2
      PHABNN=ATAN2(AIABNN,RABNN)*RAD
      COABNN=RABNN**2+AIABNN**2
      PHABPN=ATAN2(AIABPN,RABPN)*RAD
      COABPN=RABPN**2+AIABPN**2
      PHABNP=ATAN2(AIABNP,RABNP)*RAD
      COABNP=RABNP**2+AIABNP**2
      RETURN
      END
```

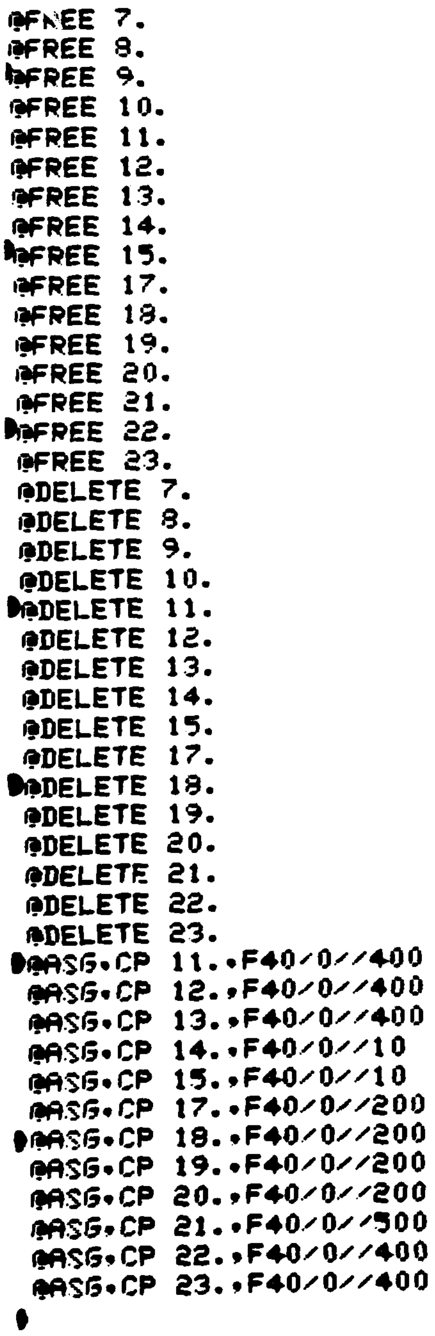
IV. B.6 SL

```
      FUNCTION SL(NDOF)
C
C  THIS FUNCTION DETERMINES A 90% SIGNIFICANCE LEVEL FOR COHERENCIES
C  GIVEN THE NUMBER OF DEGREES OF FREEDOM. THESE VALUES WERE CALCU-
C  LATED FROM 'TABLE OF THE DISTRIBUTION OF THE COEFFICIENT OF COHERENCE
C  FOR STATIONARY BIVARIATE GAUSSIAN PROCESSES' BY AMOS AND KOOPMANS,
C  1963. THE RELATIONSHIP FOR VALUES ASSOCIATED WITH NDOF >=12 WAS FOUND
C  TO BE WITHIN 3% ACCURACY.
C
C
C       VARIABLE LIST
C
C  NDOF             THE NUMBER OF DEGREES OF FREEDOM.
C  SL               SIGNIFICANCE LEVEL.
C  N                POINTER.
C
      IF(NDOF.GT.11)GO TO 200
      N=NDOF+1
      GO TO(2,2,2,3,4,5,6,7,8,9,10,11),N
    2 SL=1.
      RETURN
    3 SL=.9900
      RETURN
    4 SL=.9000
      RETURN
    5 SL=.7845
      RETURN
    6 SL=.6838
      RETURN
    7 SL=.6019
      RETURN
    8 SL=.5359
      RETURN
    9 SL=.4822
      RETURN
   10 SL=.4377
      RETURN
   11 SL=.4005
      RETURN
  200 SL=4.5578/FLOAT(NDOF)
      RETURN
      END
```

APPENDIX B

SOURCE LISTING - 'JAY.RUNALL'

APPENDIX B - 'JAY.RUNALL' LISTING



```
@FREE 7.
@FREE 8.
@FREE 9.
@FREE 10.
@FREE 11.
@FREE 12.
@FREE 13.
@FREE 14.
@FREE 15.
@FREE 17.
@FREE 18.
@FREE 19.
@FREE 20.
@FREE 21.
@FREE 22.
@FREE 23.
@DELETE 7.
@DELETE 8.
@DELETE 9.
@DELETE 10.
@DELETE 11.
@DELETE 12.
@DELETE 13.
@DELETE 14.
@DELETE 15.
@DELETE 17.
@DELETE 18.
@DELETE 19.
@DELETE 20.
@DELETE 21.
@DELETE 22.
@DELETE 23.
@ASG,CP 11.,F40/0//400
@ASG,CP 12.,F40/0//400
@ASG,CP 13.,F40/0//400
@ASG,CP 14.,F40/0//10
@ASG,CP 15.,F40/0//10
@ASG,CP 17.,F40/0//200
@ASG,CP 18.,F40/0//200
@ASG,CP 19.,F40/0//200
@ASG,CP 20.,F40/0//200
@ASG,CP 21.,F40/0//500
@ASG,CP 22.,F40/0//400
@ASG,CP 23.,F40/0//400
```

'JAY.RUNALL' (CONT'D.)

```
@USE 4•FEBFILE.
@XQT JAY.GET
VACM      1    4  500 1000    1    0
    2    2    7    1    8
@XQT JAY.GET
VACM      2    5  300 1000    1    0
    2    2    9    1   10
@XQT JAY.FOURCO
      1024         1         0
@XQT JAY.RCSPEC
        1.    0    0    2    3    0
@XQT JAY.RSPEC
        1.    0    0    1    3    5
    1    1  100    5  900    1 1500    3 2000    2
        1.    0    0    2    4    0
@ASG•CP  PLOT1•F40/0//300
@ASG•T  16
@DATA•I 16
@ADD•D JAY.ICAT
@END
@ASG•T  24
@DATA•I 24
@ADD•D JAY.USER
@END
@ASG•T 25
@DATA•I 25
@ADD•D JAY.ICAT
@END
@XQT JAY.PLOT1/RUN
@COPY P$L$T$.•PLOT1
```

APPENDIX C

SOURCE LISTING - 'MAP' DATASET

APPENDIX C - 'MAP' DATASET LISTINGS

JAY.GETMAP

```
IN JAY.GET
LIB SYSTEMS*SUBLIB.
END
```

JAY.FOURCMAP

```
IN JAY.FOURCO
IN JAY.FFT
IN JAY.FFTWIND
IN JAY.FFTPWHITE
```

JAY.RSMAP

```
IN JAY.RSMAIN
IN JAY.RASCALC
IN JAY.SWAP
IN JAY.RASAVRG
IN JAY.RASBAVRG
IN JAY.RASSTAT
IN JAY.RSL
IN JAY.CONINT
```

JAY.RCSMAP

```
IN JAY.RXMAIN
IN JAY.RCSCALC
IN JAY.RCSSWAP
IN JAY.RCSAVRG
IN JAY.RCSBAVRG
IN JAY.RCSPHCO
IN JAY.RSL
```

APPENDIX D

Source Listing - 'JAY. USER'

APPENDIX D - 'JAY.USER' LISTING

```
  0
  3     3     1     1     0     0     0     0     0     0     0     0     0     0
  1   500     0     0     0     0     0     0     0     0     0     0     0     0
  0   500     0     0     0     0     0     0     0     0     0     0     0     0
  1   500     0     0     0     0     0     0     0     0     0     0     0     0
  1   500     0     0     0     0     0     0     0     0     0     0     0     0
  0     0     0     0     0     0     0     0     0     0     0     0     0     0
  0     0     0     0     0     0     0     0     0     0     0     0     0     0
```

APPENDIX E - SOURCE LISTINGS

PLOTTING PROGRAM

I. Main Program - BIGPLT

II. Subprograms

A. ABUTMS
B. ALFSET
C. BOTTOM
D. CONINT
E. DECADE
F. DOWN
G. LABEL
H. MINMAX
I. MNPL
J. SETMES
K. SETUP
L. TOP
M. UP

I. BIGPLT

```
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C                                                                     C
C    USER CONTROL:                                                    C
C                                                                     C
C      USER CONTROL OF THE GRAPHICS OUTPUT IS ACCOMPLISHED VIA TWO    C
C      DATA SETS WHOSE FORTRAN REFERENCE NUMBERS ARE CALLED KU AND    C
C      KD IN THE MAIN PROGRAM. KU CONTAINS CONTROL DATA AND KD        C
C      CONTAINS USER SUPPLIED LABELS.                                 C
C                                                                     C
C      KU (ALL RECORDS ARE 15I5 FORMAT)                               C
C                                                                     C
C         FIRST CARD - ONE FIELD READ     (ENTERS AS KLAB)            C
C                                                                     C
C           FIELD CONTAINS                                            C
C             1                  =>      USER SUPPLIED LABELS ARE TO BE C
C                                        READ INTO ARRAY ICAT FROM KD C
C             0                  =>      NO USER LABELS SUPPLIED      C
C                                                                     C
C         SECOND CARD - FOUR FIELDS READ   (ENTER AS NPL(1)-(4) )     C
C                                                                     C
C           THE FOUR FIELDS CORRESPOND IN ORDER TO THE FOUR PLOTS     C
C                                                                     C
C           FIELD CONTAINS:                                           C
C             0                  =>      CORRESPONDING PLOT NOT DRAWN C
C             NEG. NUMBER        =>      CATALOG OF USER SUPPLIED     C
C                                        LABELS TO BE USED FOR THE    C
C                                        CORRESPONDING PLOT           C
C             POS. NUMBER        =>      DEFAULT CATALOG TO BE USED   C
C                                        FOR THE CORRESPONDING PLOT   C
C             NUMBER WHOSE                                            C
C             ABSOLUTE VALUE                                          C
C             IS   1             =>      X-AXIS LOG   Y-AXIS LINEAR   C
C                  2             =>      X-AXIS LINEAR Y-AXIS LINEAR  C
C                  3             =>      X-AXIS LOG   Y-AXIS LOG      C
C                                                                     C
C         REMAINING CARDS - NINE FIELDS READ (ENTERED AS NBOT,NPTS,   C
C                                                   AND IT(1)-(7) )   C
C                                                                     C
C           THE REMAINING CARDS CORRESPOND IN ORDER TO THE PLOTS      C
C           WHICH ARE TO BE DRAWN                                     C
C                                                                     C
C           FIELD #1 CONTAINS:                                        C
C             0                  =>      MOORING DATA NOT INCLUDED ON C
C                                        PLOT                         C
C             1                  =>      MOORING DATA APPEARS ON PLOT C
C                                                                     C
C           FIELD #2 CONTAINS THE NUMBER OF DATA POINTS WHICH THE     C
```

```
C          PLOT WILL CONTAIN. IF THIS FIELD IS ZERO OR BLANK, THE     C
C          PROGRAM WILL ASSUME ALL POINTS ARE TO BE INCLUDED.         C
C                                                                     C
C          FIELDS #3 - 9 WILL ONLY BE READ IF USER SUPPLIED LABELS    C
C          ARE TO BE USED IN THE CORRESPONDING PLOT. THE PROGRAM      C
C          READS THESE VALUES INTO ARRAY IT. SEE DOCUMENTATION OF     C
C          ROUTINES TOP AND SETUP FOR FURTHER EXPLANATION.            C
C                                                                     C
C      KD  (ALL RECORDS ARE 12A6 FORMAT)
C                                                                     C
C         EACH RECORD SHOULD CONTAIN A CHARACTER STRING NOT TO        C
C         EXCEED 71 CHARACTERS FOLLOWED BY "$". THESE STRINGS WILL    C
C         BE WRITTEN USING THE ALPHABET CONVENTIONS OF SUBROUTINE     C
C         ALFSET, I.E., INSTRUCTIONAL STRING OPTIONS ARE AVAILABLE.   C
C                                                                     C
C         NOTE:  KD SHOULD CONTAIN NO MORE THAN 15 RECORDS            C
C                                                                     C
C       EXAMPLE:                                                      C
C                   SUPPOSE DATA SET KU CONTAINS THE FOLLOWING CARDS  C
C                                                                     C
C                      1                                              C
C                      3    0    0   -1                               C
C                      1 3500                                         C
C                      0 4098    1    2    3    4    2    5           C
C                                                                     C
C          THE PROGRAM WOULD:                                         C
C                   - READ THE LABELS FROM KD INTO ICAT               C
C                   - DRAW THE FIRST PLOT USING DEFAULT TITLE AND     C
C                     LABELS ON A LOG-LOG AXIS.                       C
C                   - USE ONLY THE FIRST 3500 FREQUENCY VALUES AND    C
C                     INCLUDE MOORING DATA AT THE BOTTOM OF THE FIRST C
C                     PLOT                                            C
C                   - DRAW THE FOURTH PLOT ON A LOG-LINEAR AXIS USING C
C                     THE FIRST THREE RECORDS FROM KD AS THE LINES OF C
C                     TITLE, THE FOURTH RECORD AS X-AXIS LABEL, AND   C
C                     THE SECOND AND FIFTH RECORDS AS Y-AXIS LABELS   C
C                   - THE FOURTH PLOT WOULD USE 4098 POINTS AND WOULD C
C                     NOT CONTAIN ANY MOORING INFORMATION             C
C                                                                     C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
      REAL X(4100),Y(4100),ZX(2),ZY(2)
      INTEGER LAB(12),ICAT(12,30,2),IPAK(120),NPL(10),IT(15)
      COMMON LAB,ICAT,IPAK,X,Y
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C                                                                     C
C      SIZING PARAMETERS    (ALL DISTANCES ARE IN INCHES)             C
C                                                                     C
C         P          TOTAL HORIZONTAL SIZE OF THE SPACE WHICH WILL    C
C                    BE DEDICATED TO AXIS FRAMES.                     C
C                                                                     C
C         Q          TOTAL VERTICAL SIZE OF THE SPACE WHICH WILL BE   C
C                    DEDICATED TO AXIS FRAME(S). THIS DOES NOT        C
C                    INCLUDE SPACE FOR TITLE OR STORY.                C
```

```
C                                                                        C
C        G            SIZE OF THE VERTICAL SEPARATION OF GRAPH FRAMES   C
C                     WHEN THERE IS MORE THAN ONE FRAME PER PAGE.       C
C                                                                        C
C     XPOS,YPOS       HORIZONTAL AND VERTICAL DISTANCES SEPARATING      C
C                     THE PHYSICAL ORIGIN OF THE LOWEST PLOT FRAME      C
C                     FROM THE LOWER LEFT CORNER OF THE PAGE.           C
C                                                                        C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
      P=6.
      Q=6.5
      G=.5
      XPOS=1.5
      YPOS=3.0
C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C                                                                        C
C      FORTRAN REFERENCE NUMBERS FOR DATA SETS                           C
C                                                                        C
C        KR           ROTARY DATA                                        C
C        KRX          ROTARY CROSS DATA                                  C
C        KCI          CONFIDENCE INTERVAL DATA                           C
C        KDD          DEFAULT LABELS CATALOG                             C
C        KF           DATA SET CONTAINING CURRENT METER INFORMATION      C
C        KU           USER CONTROL CARDS                                 C
C        KD           USER SUPPLIED LABELS CATALOG                       C
C                                                                        C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
      KR=12
      KRX=11
      KCI=14
      KF=7
      KF1=KF
      KU=24
      KD=25
      KDD=16
      KTEST=0
CC
CC      LOAD DEFAULT LABELS INTO ARRAY ICAT
CC
        DO 40 J=1,30
        READ(KDD,55)  (ICAT(I,J,1),I=1,12)
40      CONTINUE
C
        DO 30 J=16,30
        READ(KDD,55)  (ICAT(I,J,2),I=1,12)
30      CONTINUE
CC
CC      DOES USER WISH TO SUPPLY LABELS ???
CC
      READ(KU,99) KLAB
      IF(KLAB.EQ.0) GO TO 60
```

BIGPLT (CONT'D.)

```
CC
CC       READ USER LABELS
CC
         DO 50 J=1,KLAB
         READ(KD,55)   (ICAT(I,J,2),I=1,12)
50       CONTINUE
55     FORMAT(12A6)
C
CC
CC       READ USER CONTROL DATA
CC
60     READ(KU,99)   (NPL(J),J=1,10)
       CALL COMPRS
C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C       FIRST PLOT     (SEE FIGURE E-1 ON NEXT PAGE FOR FLOW CHART)   C
C                                                                    C
C         THIS PROGRAM SEGMENT PLOTS THE CLOCKWISE AND ANTI-CLOCK-   C
C         WISE COMPONENTS OF ENERGY DENSITY ON A SINGLE COORDINATE  C
C         FRAME. 90% CONFIDENCE LIMITS ARE PLOTTED ON THE SAME AXIS C
C         SYSTEM USING A DECADE LINE AS REFERENCE BASE.              C
C                                                                    C
C         NOTE:  IF USER DOES NOT SPECIFY A LOG-LOG AXIS SET-UP      C
C                (NPL(1)=3 OR -3), CONFIDENCE LIMITS PLOT WILL       C
C                APPEAR DISTORTED.                                   C
C                                                                    C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
100    IF(NPL(1).EQ.0) GO TO 200
C
C   ORDER STRINGS WHICH WILL BE USED AS TITLES AND LABELS.
C
       IT(1)=6
       IT(2)=3
       IT(3)=0
       IT(4)=1
       IT(5)=2
C
C  PREPARE FOR THE PLOT.
C
      REWIND KR
      READ (KR,90) NPTS
      NPTS=NPTS-1
      CALL SETUP(NPL(1),KU,NCAT,NBOT,NOPT,NPTS,IT)
      WRITE(6,99) NCAT,NBOT,NOPT,NPTS
C
      CALL DOWN(NBOT,YPOS,Q)
C
      QQ=Q
C
C  FIND AND ROUND OFF PLOT LIMITS.
C
```

BIGPLT (CONT'D.)

First Plot - flow chart

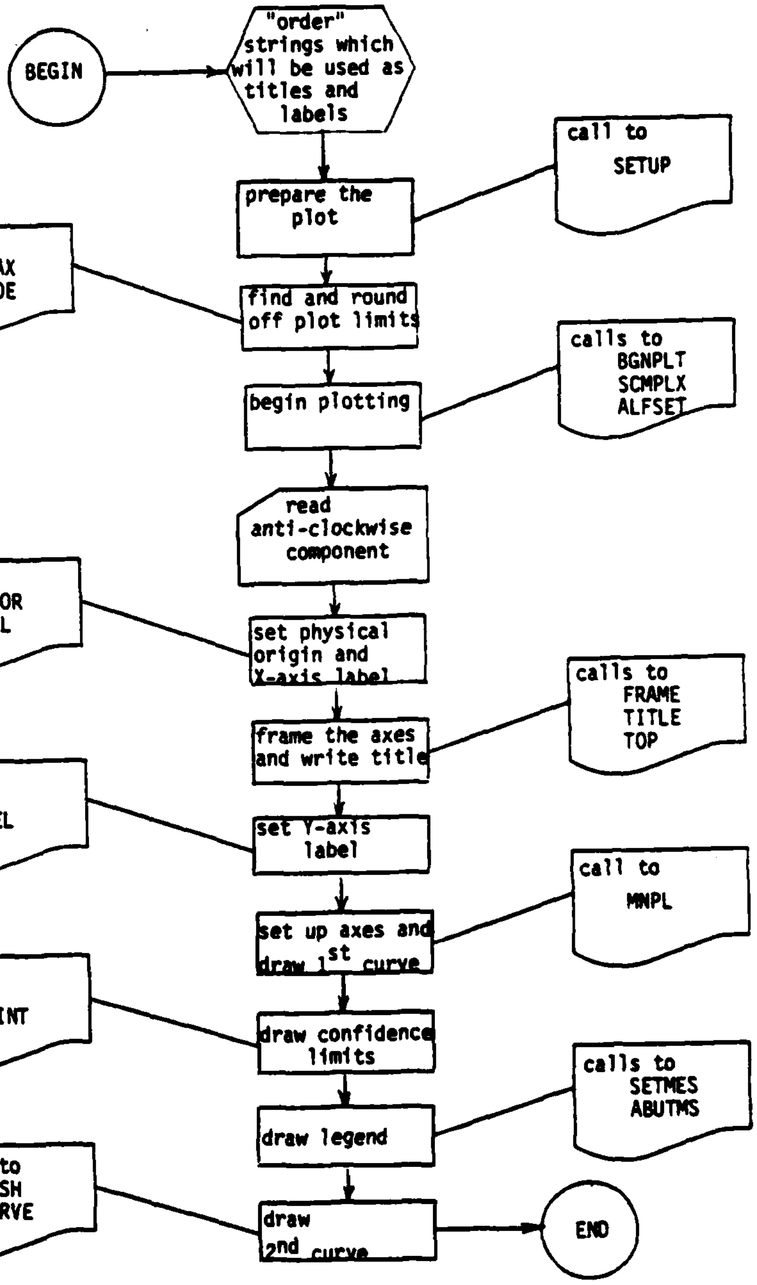


Figure E-1

BIGPLT (CONT'D.)

```
      READ(KR,90)  (X(J),J=1,NPTS)
      REWIND KR
      READ(KR,90) DUM
      READ(KR,91)  (Y(J),J=1,NPTS)
      XMN=X(1)
      XMX=X(NPTS)
      CALL MINMAX(TMN,TMX,Y(1),Y(1),NPTS)
      REWIND KR
      READ(KR,90) DUM
      READ(KR,92)  (Y(J),J=1,NPTS)
      CALL MINMAX(YMN,YMX,TMN,TMX,NPTS)
      CALL DECADE(YMN,YMX)
      YMN=YMN/100.
      DX=YMN*10.
C
C   BEGIN PLOTTING
C
      CALL BGNPL(0)
      CALL SCMPLX
      CALL ALFSET
C
C   READ ANTI-CLOCKWISE COMPONENT
C
      REWIND KR
      READ(KR,90) DUM
      READ(KR,91)  (Y(J),J=1,NPTS)
C
C   SET PHYSICAL ORIGIN AND X-AXIS LABEL
C
      CALL PHYSOR(XPOS,YPOS)
      CALL LABEL(NCAT,IT(4))
C
C   FRAME THE AXES AND WRITE TITLE
C
      CALL TITLE(1H ,1,LAB,100,C,0,P,Q)
      CALL FRAME
      CALL TOP(NCAT,IT)
C
C   SET Y-AXIS LABEL
C
      CALL LABEL(NCAT,IT(5))
      STP=(YMX-YMN)/5.
C
C   SET UP AXES AND DRAW FIRST CURVE
C
      CALL MNPL(NOPT,XMN,XMX,YMN,YMX,STP,NPTS,P,QQ)
C
C   DRAW CONFIDENCE LIMITS
C
      CALL CONINT(KCI,X(NPTS),DX)
      CALL BOTTOM(NBOT,0.0,KF)
      CALL UP(NBOT,YPOS,Q)
```

BIGPLT (CONT'D.)

```
C
C   DRAW LEGEND
C
      QM=QQ-.15
      CALL SETMES(4,3.,QM)
      CALL ABUTMS(19)
      QM=QM-.25
      CALL SETMES(5,3.,QM)
      CALL ABUTMS(17)
C
C   DRAW SECOND CURVE
C
      REWIND KR
      READ(KR,90) DUM
      READ(KR,92) (Y(J),J=1,NPTS)
      CALL DASH
      CALL CURVE(X,Y,NPTS,0)
      D=1.
      CALL ENDPL(1)
C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C       SECOND PLOT  (see figure E-2 on next page for flow chart)    C
C                                                                    C
C         THIS PROGRAM SEGMENT PLOTS THE SAME INFORMATION AS THE     C
C         FIRST PLOT. THE FORMAT IS CHANGED, HOWEVER, SO THAT THE    C
C         CLOCKWISE AND ANTI-CLOCKWISE COMPONENTS ARE PLOTTED ON     C
C         SEPARATE COORDINATE FRAMES.                                C
C                                                                    C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
200   IF(NPL(2).EQ.0) GO TO 300
CC
CC   ORDER STRINGS WHICH WILL BE USED AS TITLE AND LABELS
CC
C     SET IT
      IT(1)=6
      IT(2)=3
      IT(3)=0
      IT(4)=1
      IT(5)=2
      IT(6)=2
C
      REWIND KR
      READ(KR,90) NPTS
      NPTS=NPTS-1
      CALL SETUP(NPL(2),KU,NCAT,NBOT,NOPT,NPTS,IT)
C
      CALL DOWN(NBOT,YPOS,Q)
C
      QQ=(Q-6)/2.
      QQQ=QQ+6
CC
CC   FIND AND ROUND OFF PLOT LIMITS
CC
```

Second Plot flow chart

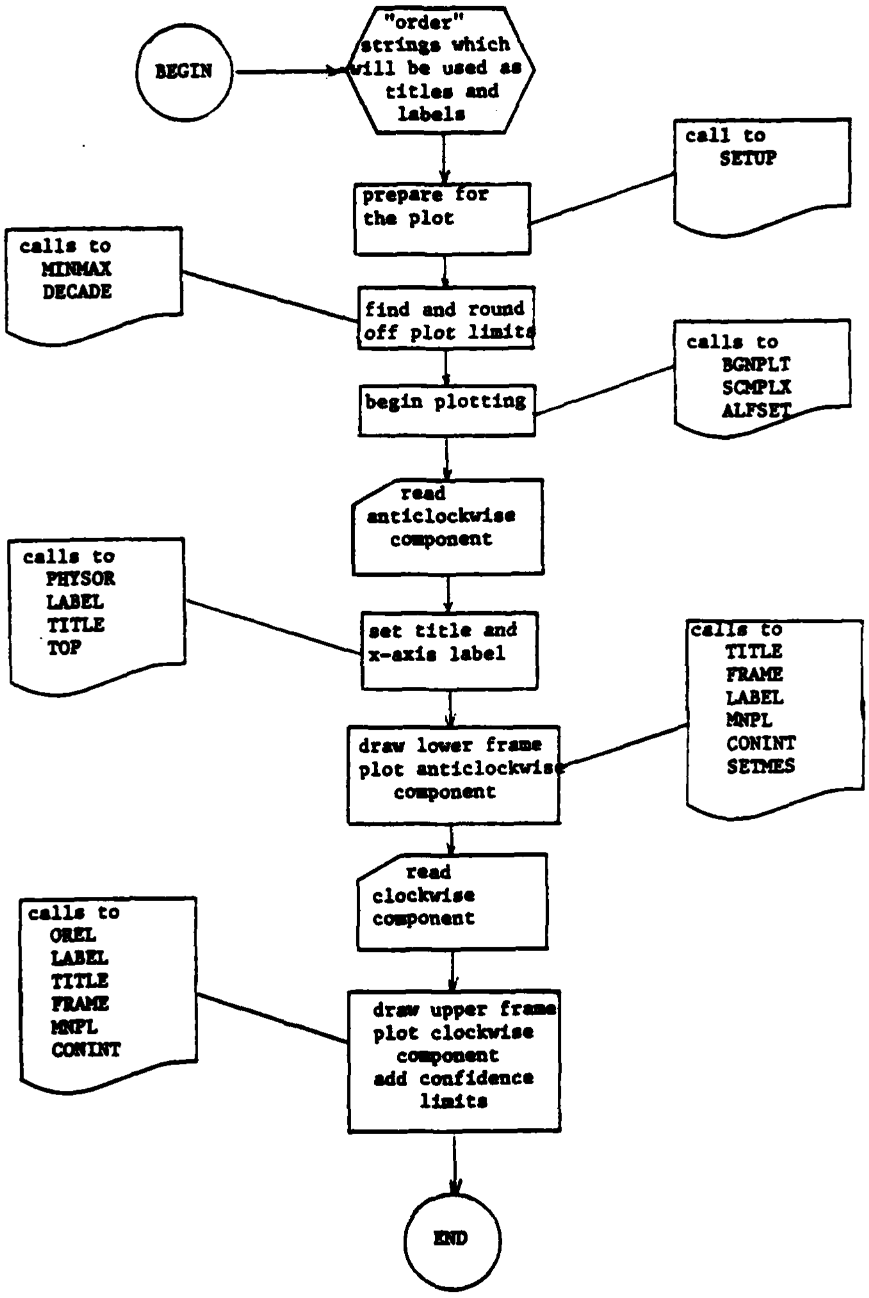

BEGIN
"order" strings which will be used as titles and labels
call to SETUP
prepare for the plot
calls to MINMAX DECADE
find and round off plot limits
calls to BGNPLT SCMPLX ALFSET
begin plotting
read anticlockwise component
calls to PHYSOR LABEL TITLE TOP
set title and x-axis label
calls to TITLE FRAME LABEL MNPL CONINT SETMES
draw lower frame plot anticlockwise component
read clockwise component
calls to OREL LABEL TITLE FRAME MNPL CONINT
draw upper frame plot clockwise component add confidence limits
END

Figure E-2

BIGPLT (CONT'D.)

```
      READ(KR,90)  (X(J),J=1,NPTS)
      REWIND KR
      READ(KR,90)  DUM
      READ(KR,91)  (Y(J),J=1,NPTS)
      XMN=X(1)
      XMX=X(NPTS)
      CALL MINMAX(TMN,TMX,Y(1),Y(1),NPTS)
      REWIND KR
      READ(KR,90)  DUM
      READ(KR,92)  (Y(J),J=1,NPTS)
      CALL MINMAX(YMN,YMX,TMN,TMX,NPTS)
      CALL DECADE(YMN,YMX)
      DX=YMN*10.
CC
CC    BEGIN PLOTTING
CC
      CALL BGNPL(0)
      CALL SCMPLX
      CALL ALFSET
CC
CC    READ ANTI-CLOCKWISE COMPONENT
CC
      REWIND KR
      READ(KR,90)  DUM
      READ(KR,91)  (Y(J),J=1,NPTS)
CC
CC    DRAW LOWER FRAME AND PLOT ANTICLOCKWISE COMPONENT
CC
      CALL PHYSOP(XPOS,YPOS)
      CALL TITLE(1H ,1,0,0,0,0,P,Q)
      CALL TOP(NCAT,IT)
      CALL ENDGR(2)

      CALL LABEL(NCAT,IT(4))
      CALL TITLE(IH ,1,LAB,100,0,0,P,QQ)
      CALL FRAME
      CALL LABEL(NCAT,IT(5))
      NST=(YMX-YMN)/8
      YST=NST
      CALL MNPL(NOPT,XMN,XMX,YMN,YMX,YST,NPTS,P,QQ)
      CALL BOTTOM(NBOT,0.0,KF)
      CALL UP(NBOT,YPOS,Q)
      CALL CONINT(KCI,X(NPTS),DX)

      CALL SETMES(5,.5,.1)
      CALL ENDGR(2)
CC
CC    READ CLOCKWISE COMPONENT
CC
      REWIND KR
      READ(KR,90)  DUM
      READ(KR,92)  (Y(J),J=1,NPTS)
```

BIGPLT (CONT'D.)

```
CC
CC   DRAW UPPER FRAME AND PLOT CLOCKWISE COMPONENT
CC
      CALL DREL(0.,QQQ)
      CALL LABEL(1,16)
      CALL TITLE(1H ,1,LAB,100,0,0,P,QQ)
      CALL FRAME
      CALL LABEL(NCAT,IT(6))
      CALL MNPL(NOPT,XMN,XMX,YMN,YMX,YST,NPTS,P,QQ)
C     CALL CONINT(KCI,X(NPTS),DX)
C
      CALL SETMES(4,.5,.1)
C
      CALL ENDGR(2)
      CALL ENDPL(2)
C
C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C       THIRD PLOT    (see figure E-3 on next page for flow chart)      C
C         THIS PROGRAM SEGMENT PLOTS VARIOUS HODOGRAPH PARAMETERS       C
C         FOR ROTARY AUTO-SPECTRAL DATA.                                C
C         - THE LOWER FRAME CONTAINS PLOTS OF STABILITY AND             C
C           MAXIMUM AND MINIMUM COHERENCE SQUARED VS. FREQUENCY         C
C         - THE MIDDLE FRAME CONTAINS A PLOT OF ORIENTATION (IN         C
C           DEGREES) VS. FREQUENCY                                      C
C         - THE UPPER FRAME CONTAINS A PLOT OF RATIO VS. FREQUENCY      C
C                                                                       C
C         NOTE:  USER SHOULD NOT SPECIFY A LOG SCALING OPTION FOR       C
C                THE Y-AXIS (NPL(3)=3 OR -3) SINCE ORIENTATION AND      C
C                RATIO MAY BOTH HAVE SOME NEGATIVE VALUES.              C
C                                                                       C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
300   IF(NPL(3).EQ.0) GO TO 400
CC
CC   PREPARE FOR THE PLOT
CC
C     SET IT
      IT(1)=6
      IT(2)=8
      IT(3)=15
      IT(4)=1
      IT(5)=16
      IT(6)=9
      IT(7)=16
C
      REWIND KR
      READ(KR,90) NPTS
      NPTS=NPTS-1
      CALL SETUP(NPL(3),KU,NCAT,NBOT,NOPT,NPTS,IT)
C
      CALL DOWN(NBOT,YPOS,Q)
C
```

BIGPLT (CONT'D.)

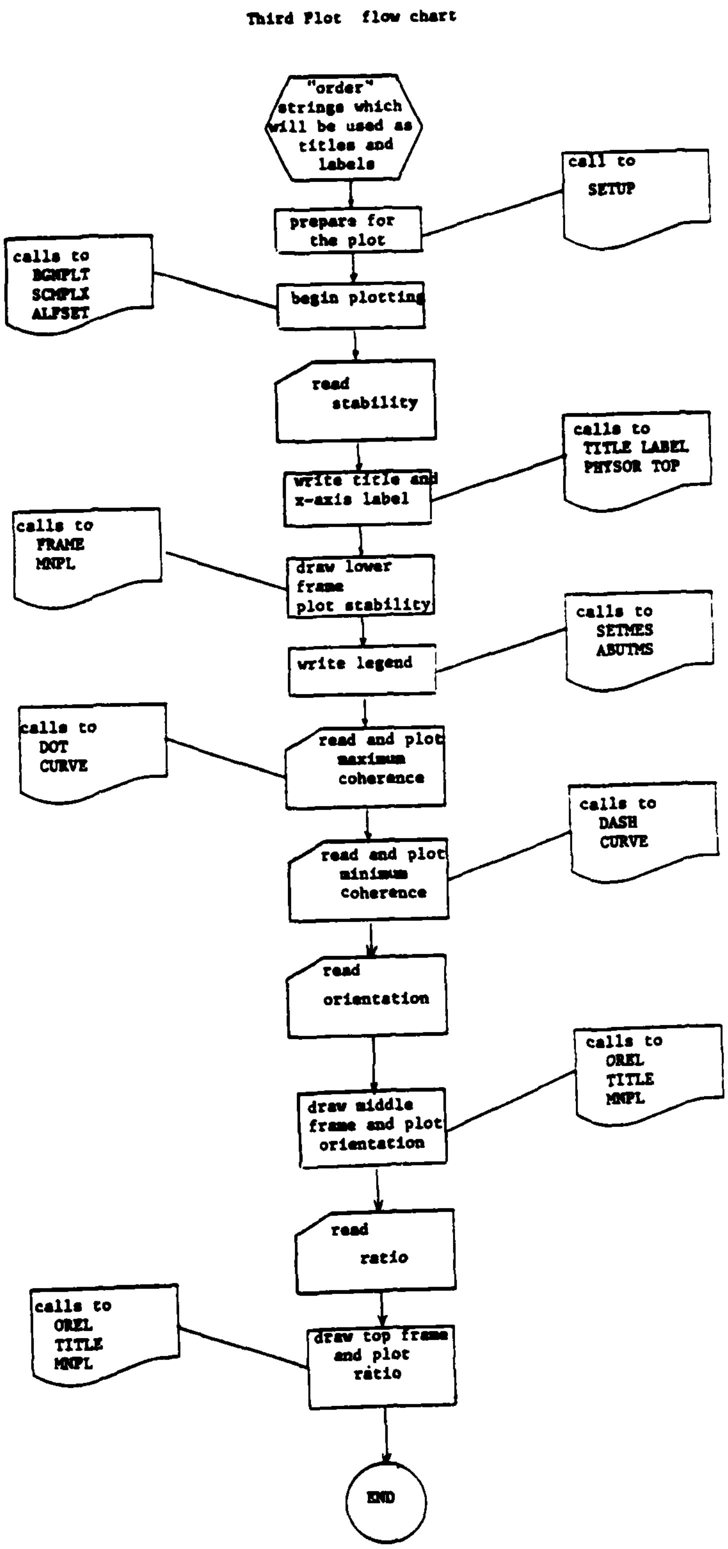

Third Plot flow chart
"order" strings which will be used as titles and labels
prepare for the plot
call to SETUP
begin plotting
calls to BGNPLT SCMPLX ALFSET
read stability
write title and x-axis label
calls to TITLE LABEL PHYSOR TOP
draw lower frame plot stability
calls to FRAME MNPL
write legend
calls to SETMES ABUTMS
read and plot maximum coherence
calls to DOT CURVE
read and plot minimum coherence
calls to DASH CURVE
read orientation
draw middle frame and plot orientation
calls to OREL TITLE MNPL
read ratio
draw top frame and plot ratio
calls to OREL TITLE MNPL
END

Figure E-3

```
      QQ=(Q-2.*G)/3.
      QQQ=QQ+G
C
      READ(KR,90)  (X(J),J=1,NPTS)
      XMN=X(1)
      XMX=X(NPTS)
C
      ZX(1)=XMN
      ZX(2)=XMX
      ZY(1)=0.
      ZY(2)=0.
CC
CC    BEGIN PLOTTING
CC
      CALL BGNPL(0)
      CALL SCMPLX
      CALL ALFSET
CC
CC    READ STABILITY
CC
C     STABILITY
      REWIND KR
      READ(KR,90)  DUM
      READ(KR,94)  (Y(J),J=1,NPTS)
CC
CC    WRITE TITLE AND X-AXIS LABEL
CC
      CALL PHYSOR(XPOS,YPOS)
      CALL TITLE(1H ,1,0,0,0,0,P,Q)
      CALL TOP(NCAT,IT)
      CALL ENDGR(3)
CC
CC    DRAW LOWER FRAME AND PLOT STABILITY
CC
      CALL LABEL(NCAT,IT(4))
      CALL TITLE(1H ,1,LAB,100,0,0,P,QQ)
      CALL YINTAX
      CALL FRAME
      CALL LABEL(NCAT,IT(5))
      CALL MNPL(NOPT,XMN,XMX,0.,1.,.25,NPTS,P,QQ)
      CALL BOTTOM(NBOT,0.0,KF)
      CALL UP(NBOT,YPOS,Q)
CC
CC   WRITE THE LEGEND
CC
      XP=.5
      YP=QQ-.25
      CALL SETMES(12,XP,YP)
      CALL ABUTMS(17)
      CALL ABUTMS(16)
      CALL ABUTMS(21)
      CALL ABUTMS(11)
```

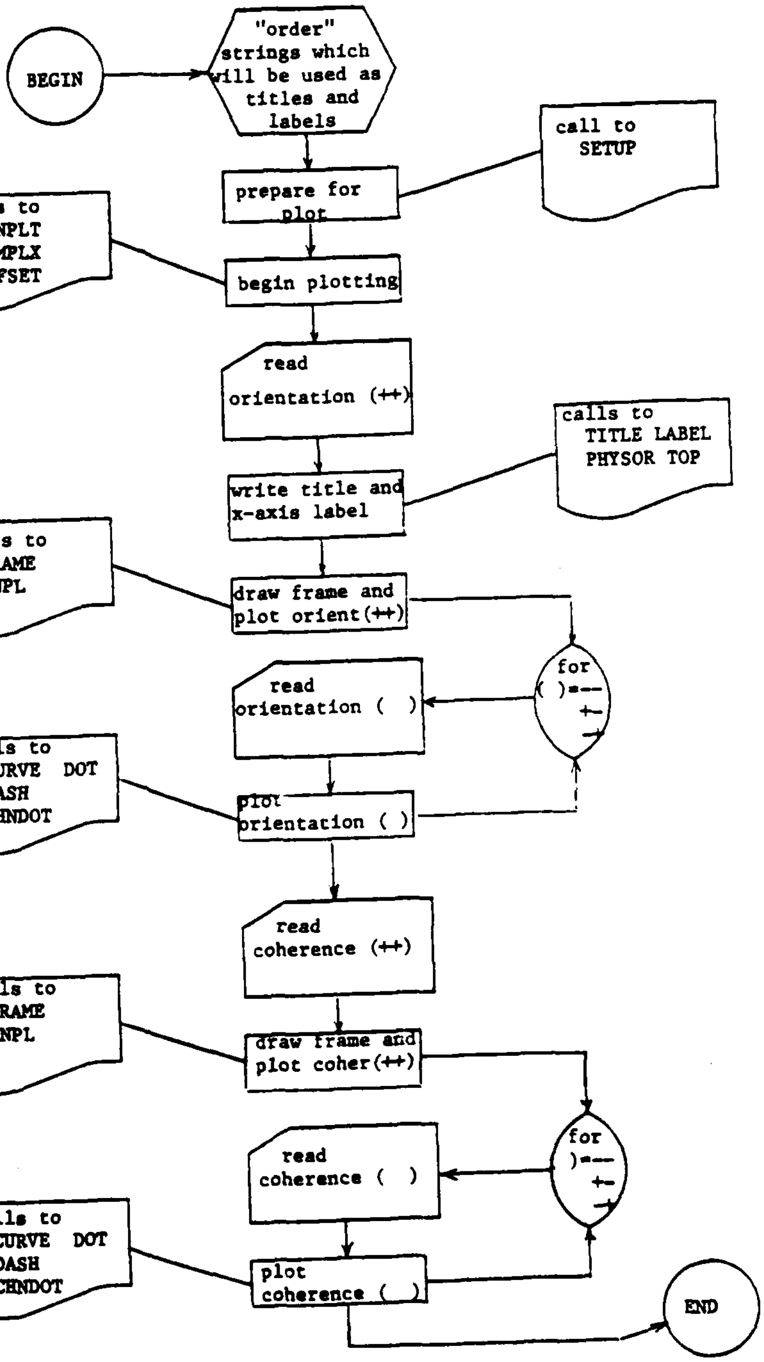
BIGPLT (CONT'D.)

```
      CALL ABUTMS(19)
      CALL ABUTMS(16)
      CALL ABUTMS(21)
      CALL ABUTMS(10)
      CALL ABUTMS(18)
CC
CC   READ AND PLOT MAXIMUM COHERENCE
CC
C     MAX COHERENCE
      REWIND KR
      READ(KR,90) DUM
      READ(KR,97) (Y(J),J=1,NPTS)
      CALL DOT
      CALL CURVE(X,Y,NPTS,0)
CC
CC   READ AND PLOT MINIMUM COHERENCE
CC
C     MIN COHERENCE
      REWIND KR
      READ(KR,90) DUM
      READ(KR,96) (Y(J),J=1,NPTS)
      CALL DASH
      CALL CURVE(X,Y,NPTS,0)
      CALL RESET('DASH')
      CALL ENDGR(3)
CC
CC   READ ORIENTATION
CC
C     ORIENTATION
      REWIND KR
      READ(KR,90) DUM
      READ(KR,93) (Y(J),J=1,NPTS)
CC
CC   DRAW MIDDLE FRAME AND PLOT ORIENTATION
CC
      CALL DREL(0.,QQQ)
      CALL LABEL(1,16)
      CALL TITLE(1H ,1,LAB,100,0,0,P,QQ)
      CALL FRAME
      CALL LABEL(NCAT,IT(6))
      CALL MNPL(NOPT,XMN,XMX,-180.,180.,90.,NPTS,P,QQ)
      CALL CURVE(ZX,ZY,2,0)
      CALL SETMES(14,XP,YP)
      CALL ENDGR(3)
CC
CC   READ RATIO
CC
C     RATIO
      REWIND KR
      READ(KR,90) DUM
      READ (KR,95) (Y(J),J=1,NPTS)
```

```
CC
CC    DRAW TOP FRAME AND PLOT RATIO
CC
      CALL DREL(0.,QQQ)
      CALL LABEL(1,16)
      CALL TITLE(1H ,1,LAB,100,0,0,P,QQ)
      CALL FRAME
      CALL LABEL(NCAT,IT(7))
      CALL MNPL(NOPT,XMN,XMX,-1.,1.,.5,NPTS,P,QQ)
      CALL CURVE(ZX,ZY,2,0)
      CALL SETMES(27,XP,YP)
      CALL ENDGR(3)
      CALL ENDPL(3)
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C       FOURTH PLOT    (see figure E-4 on next page for flow chart)       C
C                                                                  C
C         THIS PROGRAM SEGMENT PLOTS ROTARY CROSS SPECTRAL DATA    C
C         ON TWO COORDINATE FRAMES:                                C
C          - THE UPPER FRAME CONTAINS PLOTS OF THE VARIOUS COHE-   C
C            RENCIES (SQUARED) OF CLOCKWISE AND ANTI-CLOCKWISE     C
C            COMPONENTS AT THE TWO MOORINGS AS FUNCTIONS OF        C
C            FREQUENCY.                                            C
C          - THE LOWER FRAME CONTAINS PLOTS OF THE CORRESPONDING   C
C            PHASES.                                               C
C                                                                  C
C         NOTATIONAL CONVENTIONS:                                  C
C            (++)  =>        CLOCKWISE AT A      CLOCKWISE AT B    C
C            (+-)  =>        CLOCKWISE AT A  ANTICLOCKWISE AT B    C
C            (--)  =>    ANTICLOCKWISE AT A  ANTICLOCKWISE AT B    C
C            (-+)  =>    ANTICLOCKWISE AT A      CLOCKWISE AT B    C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
400   IF(KTEST.EQ.1) GO TO 401
      KTEST=1
      KR=13
      KCI=15
      KF=9
      KF2=KF
      GO TO 100
401   IF(NPL(4).EQ.0) GO TO 500
CC
CC    ORDER STRINGS WHICH WILL BE USED AS TITLE AND LABELS
CC
C     SET IT
      IT(1)=13
      IT(2)=15
      IT(3)=28
      IT(4)=1
      IT(5)=28
      IT(6)=15
CC
CC    PREPARE FOR PLOT
CC
```

BIGPLT (CONT'D.)

Fourth Plot flow chart



BEGIN
"order" strings which will be used as titles and labels
call to SETUP
prepare for plot
calls to BGNPLT SCMPLX ALFSET
begin plotting
read orientation (++)
calls to TITLE LABEL PHYSOR TOP
write title and x-axis label
calls to FRAME MNPL
draw frame and plot orient(++)
for ( )=-- +- -+
read orientation ( )
calls to CURVE DOT DASH CHNDOT
plot orientation ( )
read coherence (++)
calls to FRAME MNPL
draw frame and plot coher(++)
for)=-- +- -+
read coherence ( )
calls to CURVE DOT DASH CHNDOT
plot coherence ( )
END

Figure E-4

BIGPLT (CONT'D)

```
      REWIND KRX
      READ(KRX,90) NPTS
      NPTS=NPTS-1
      CALL SETUP(NPL(4),KU,NCAT,NBOT,NOPT,NPTS,IT)
C
      CALL DOWN(NBOT,YPOS,Q)
C
      READ(KRX,90)  (X(J),J=1,NPTS)
      XMN=X(1)
      XMX=X(NPTS)
C
      ZX(1)=XMN
      ZX(2)=XMX
      ZY(1)=0.
      ZY(2)=0.
      QQ=(Q-6)/2.
      QQQ=QQ+6
CC
CC    BEGIN PLOTTING
CC
      CALL BGNPL(0)
      CALL SCMPLX
      CALL ALFSET
CC
CC    READ ORIENTATION(++)
CC
C     ORIENTATION  (++)
      REWIND KRX
      READ(KRX,90) DUM
      READ(KRX,92)  (Y(J),J=1,NPTS)
CC
CC    WRITE TITLE AND X-AXIS LABEL
CC
CC
      CALL PHYSOR(XPOS,YPOS)
      CALL YINTAX
      CALL TITLE(1H ,1,0,0,0,0,P,Q)
      CALL TOP(NCAT,IT)
      CALL ENDGR(4)
CC
CC    DRAW FRAME AND PLOT ORIENTATION  (++)
CC
      CALL LABEL(NCAT,IT(4))
      CALL TITLE(1H ,1,LAB,100,0,0,P,QQ)
      CALL FRAME
      CALL LABEL(NCAT,IT(5))
      CALL MNPL(NOPT,XMN,XMX,-180.,180.,90.,NPTS,P,QQ)
      CALL CURVE(ZX,ZY,2,0)
      CALL HEIGHT(.07)
      CALL MESSAG(9HMOORING A,9,-.3,-.67)
      CALL RESET('HEIGHT')
      CALL BOTTOM(NBOT,0.0,KF1)
```

BIGPLT (CONT'D.)

```
      CALL HEIGHT(.07)
      CALL MESSAG(9HMOORING B,9,-.3,-1.87)
      CALL RESET('HEIGHT')
      CALL BOTTOM(NBOT,-1.2,KF2)
      CALL UP(NBOT,YPOS,0)
CC
CC   WRITE LEGEND
CC
      YP=QQ-.25
      CALL SETMES(22,.5,YP)
      CALL ABUTMS(23)
      CALL ABUTMS(17)
      CALL SETMES(22,2.5,YP)
      CALL ABUTMS(24)
      CALL ABUTMS(18)
      YP=YP-.25
      CALL SETMES(22,.5,YP)
      CALL ABUTMS(25)
      CALL ABUTMS(19)
      CALL SETMES(22,2.5,YP)
      CALL ABUTMS(26)
      CALL ABUTMS(20)
CC
CC   READ AND PLOT REMAINING ORIENTATION - (--),(+-),(-+)
CC
C     ORIENTATION  (--)
      REWIND KRX
      READ(KRX,90) DUM
      READ(KRX,94) (Y(J),J=1,NPTS)
      CALL DOT
      CALL CURVE(X,Y,NPTS,0)
C
C     ORIENTATION  (+-)
      REWIND KRX
      READ(KRX,90) DUM
      READ(KRX,96) (Y(J),J=1,NPTS)
      CALL DASH
      CALL CURVE(X,Y,NPTS,0)
C
C     ORIENTATION  (-+)
      REWIND KRX
      READ(KRX,90) DUM
      READ(KRX,98) (Y(J),J=1,NPTS)
      CALL CHNDOT
      CALL CURVE(X,Y,NPTS,0)
      CALL RESET('CHNDOT')
      CALL ENDGR(4)
CC
CC   READ COHERENCE (++)
CC
C     COHERENCE  (++)
      REWIND KRX
```

BIGPLT (CONT'D.)

```
      READ(KRX,90) DUM
      READ(KRX,91) (Y(J),J=1,NPTS)
CC
CC    DRAW FRAME AND PLOT COHERENCE(++)
CC
      CALL OREL(0.,QQQ)
      CALL LABEL(1,16)
      CALL TITLE(1H ,1,LAB,100,0,0,P,QQ)
      CALL FRAME
      CALL LABEL(NCAT,IT(6))
      CALL MNPL(NOPT,XMN,XMX,0.,1.,.25,NPTS,P,QQ)
CC
CC    WRITE LEGEND
CC
      YP=YP+.25
      CALL SETMES(21,.5,YP)
      CALL ABUTMS(23)
      CALL ABUTMS(17)
      CALL SETMES(21,2.5,YP)
      CALL ABUTMS(24)
      CALL ABUTMS(18)
      YP=YP-.25
      CALL SETMES(21,.5,YP)
      CALL ABUTMS(25)
      CALL ABUTMS(19)
      CALL SETMES(21,2.5,YP)
      CALL ABUTMS(26)
      CALL ABUTMS(20)
CC
CC    PLOT REMAINING COHERENCE
CC
CC
C     COHERENCE  (--)
      REWIND KRX
      READ(KRX,90) DUM
      READ(KRX,93) (Y(J),J=1,NPTS)
      CALL DOT
      CALL CURVE(X,Y,NPTS,0)
C
C     COHERENCE  (+-)
      REWIND KRX
      READ(KRX,90) DUM
      READ(KRX,95) (Y(J),J=1,NPTS)
      CALL DASH
      CALL CURVE(X,Y,NPTS,0)
C
C     COHERENCE  (-+)
      REWIND KRX
      READ(KRX,90) DUM
      READ(KRX,97) (Y(J),J=1,NPTS)
      CALL CHNDOT
      CALL CURVE(X,Y,NPTS,0)
```

BIGPLT (CONT'D.)

```
C
      CALL ENDGR(4)
      CALL ENDPL(4)
C
 90   FORMAT(A6)
 91   FORMAT(6X,A6)
 92   FORMAT(12X,A6)
 93   FORMAT(18X,A6)
 94   FORMAT(24X,A6)
 95   FORMAT(30X,A6)
 96   FORMAT(36X,A6)
 97   FORMAT(42X,A6)
 98   FORMAT(48X,A6)
 99   FORMAT(15I5)
C
  500  CALL DONEPL
C
      STOP
      END
```

ABUTMS

```
      SUBROUTINE ABUTMS(ITEM)
      INTEGER LAB(12),ICAT(12,30,2)
      COMMON LAB,ICAT
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><C
C       SUBROUTINE ABUTMS TAKES A SELECTED LABEL FROM THE DEFAULT  C
C       CATALOG AND CONCATENATES IT WITH THE LABEL WHICH WAS       C
C       PLACED ON THE PLOT BY THE IMMEDIATELY PRECEEDING CALL TO   C
C       SETMES OR ABUTMES.                                         C
C                                                                  C
C       ON ENTRY:                                                  C
C                                                                  C
C         ITEM    IS THE CATALOG NUMBER OF THE SELECTED LABEL      C
C                                                                  C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><C
      CALL HEIGHT(.1)
      CALL LABEL(1,ITEM)
      CALL MESSAG(LAB,100,'ABUT','ABUT')
      CALL RESET('HEIGHT')
      RETURN
      END
EOF:20
.0:>
```

ALFSET

```
      SUBROUTINE ALFSET
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><C
C       SUBROUTINE ALFSET SETS FOUR ALPHABETS WITH CORRESPONDING     C
C       ESCAPE CHARACTERS (SEE DISSPLA INTERMEDIATE MANUAL SEC-      C
C       TIONS 19.1-19.3).                                            C
C                                                                    C
C                  ALPHABET                   ESCAPE CHARACTER       C
C                                                                    C
C               BASALF - L/CSTD                      -               C
C               MIXALF - STAND                      "("              C
C               MX3ALF - L/CGR                      "!"              C
C               MX4ALF - INSTR                      "◆"              C
C                                                                    C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><C
      CALL BASALF('L/CSTD')
      CALL MIXALF('STAND')
      CALL MX3ALF('L/CGR','!')
      CALL MX4ALF('INSTR','◆')
      RETURN
      END
EOF:20
0:>
```

BOTTOM

```
      SUBROUTINE BOTTOM(NBOT,Y,KF)
      INTEGER LAB(12),ICAT(12,30,2),IPAK(120),NDOC(3),L(12)
      COMMON LAB,ICAT,IPAK
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C      SUBROUTINE BOTTOM USES DISSPLA ROUTINE MESSAG TO WRITE         C
C      CURRENT METER DATA BELOW THE PLOT.                             C
C                                                                     C
C      DATA READ FROM FEB FILES IS STORED IN ARRAY IPAK. LABELS       C
C      FOR THE DATA ARE STORED IN ARRAY ICAT. THE ROUTINE USES        C
C      ARRAYS NDOC AND LAB AS VEHICLES FOR CARRYING EACH DATUM        C
C      AND ITS CORRESPONDING LABEL TO MESSAG.                         C
C                                                                     C
C        ON ENTRY:                                                    C
C                                                                     C
C          NBOT                  IS ESCAPE PARAMETER                  C
C                                0 - RETURN WITHOUT EXECUTION         C
C                                1 - CARRY OUT ROUTINE                C
C                                                                     C
C          Y                     IS CURRENT HEIGHTH OF PLOT ORIGIN    C
C                                                                     C
C          KF                    UNIT NUMBER FOR FILE CONTAINING      C
C                                MOORING DATA                         C
C                                                                     C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
24:>
```

BOTTOM (cont)

```
C
      IF(NBOT.EQ.0) RETURN
C
      REWIND KF
      READ(KF,77) (IPAK(J),J=1,7)
      READ(KF,78) (IPAK(J),J=8,15)
      READ(KF,79)  IPAK(16)
      READ(KF,76) (IPAK(J),J=17,19)
76    FORMAT(1X,3A6)
77    FORMAT(19X,7A6)
78    FORMAT(1X,2A6,12X,6A6)
79    FORMAT(55X,A6)
C
      L(1)=0
      L(2)=2
      L(3)=4
      L(5)=6
      L(4)=5
      L(5)=6
      L(6)=7
      L(7)=8
      L(8)=9
      L(9)=12
      L(10)=15
      L(11)=18
      L(12)=19
C
      XX=.5
      YY=Y-.5
C
      CALL HEIGHT(.07)
        DO 7 J=1,11
        KL=L(J)
        K=L(J+1)-L(J)
          DO 6 M=1,K
          NDOC(M)=IPAK(KL+M)
  6       CONTINUE
C
        IF(J.NE.7) GO TO 5
        XX=3.5
        YY=Y-.5
C
  5     YY=YY-.17
        LL=15+J
        KK=K*6
        CALL LABEL(2,LL)
        CALL MESSAG(LAB,100,XX,YY)
        CALL MESSAG(NDOC,KK,'ABUT','ABUT')
  7     CONTINUE
      CALL RESET('HEIGHT')
      RETURN
      END
76:>
```

CONINT

```
      SUBROUTINE CONINT(KCI,XMAX,DX)
      REAL X(3),U(3),L(3)
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><<C
C       SUBROUTINE CONINT(KCI,XMAX,DX) MAKES USE OF DISSPLA             C
C       ROUTINE CURVE TO DRAW CONFIDENCE LIMITS ON THE PLOTS.           C
C                                                                       C
C       EACH INTERVAL HAS ITS ENDPOINTS STORED IN THE ARRAY             C
C       X WITH THE CORRESPONDING UPPER AND LOWER 90% CONFIDENCE         C
C       LIMITS STORED IN ARRAYS U AND L. CURVE IS CALLED TO             C
C       DRAW THESE ON THE PLOT USING THE LOWEST AVAILABLE DEC-          C
C       ADE AS A REFERENCE BASE.                                        C
C                                                                       C
C       INPUT PARAMETERS:                                               C
C                                                                       C
C        KCI     FORTRAN REFERENCE NUMBER FOR THE DATA SET              C
C                CONTAINING THE CONFIDENCE LIMIT DATA.                  C
C                                                                       C
C        XMAX    LARGEST X-VALUE (FREQUENCY) IN THE ENERGY              C
C                DENSITY PLOT.                                          C
C                                                                       C
C        DX      VALUE OF THE LOWEST DECADE ON THE Y-AXIS               C
C                WHICH IS ABOVE THE PLOT ORIGIN.                        C
C                                                                       C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><<C
24:>
```

(see figure E-5 on next page for flow chart)

Subroutine CONINT Flow Chart

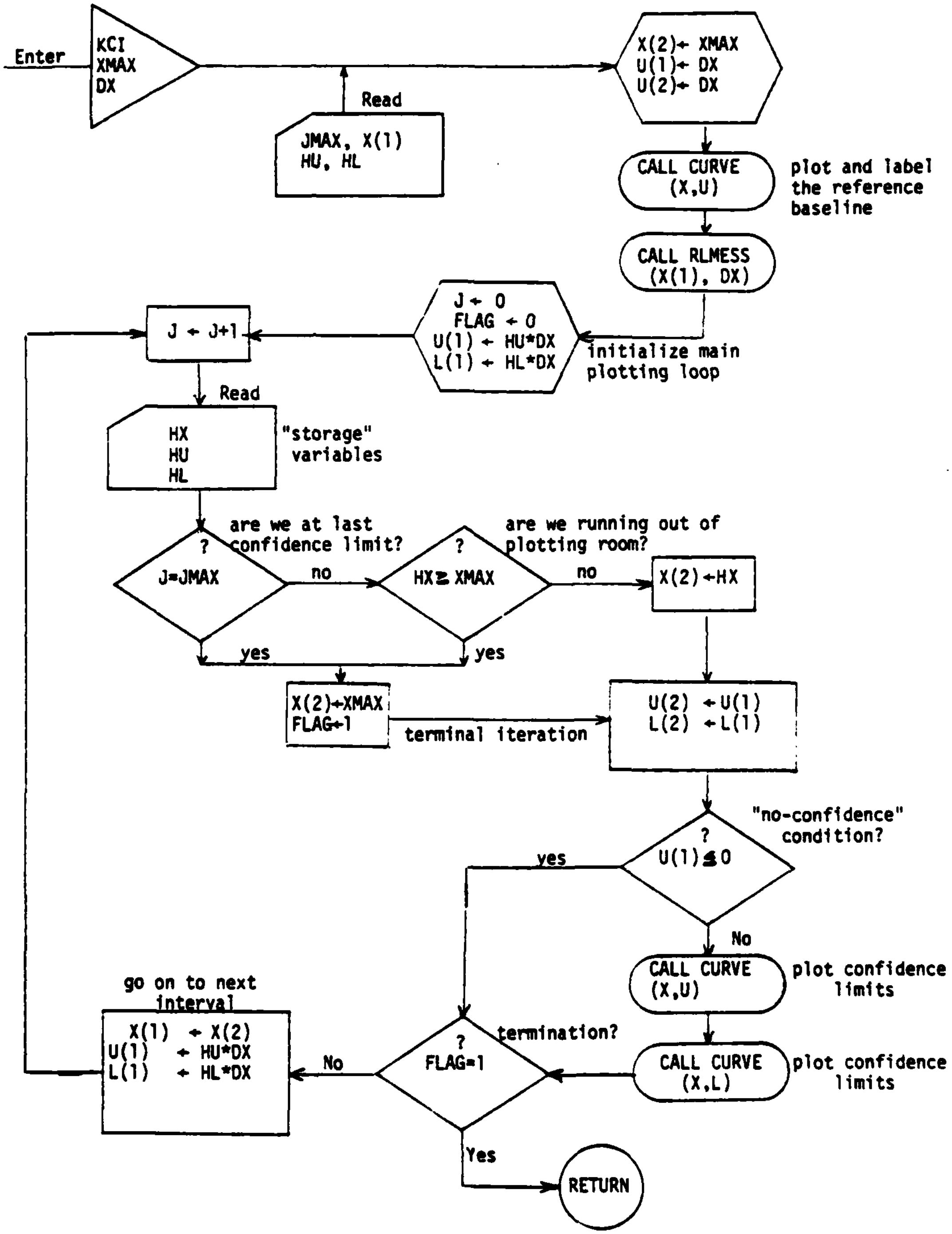


Figure E-5

```
      REWIND KCI
      READ(KCI,6) JMAX
      READ(KCI,6) X(1),HU,HL
C
C<><><><><><><><><><><><><><><><>C
C  PLOT THE REFERENCE DECADE     C
C<><><><><><><><><><><><><><><><>C
      X(2)=XMAX
      U(1)=DX
      U(2)=DX
      CALL DOT
      CALL CURVE(X,U,2,0)
      CALL RESET('DOT')
      CALL HEIGHT(.07)
      CALL MESSAG('90% CONFIDENCE LIMITS',21,.5,.1)
      CALL RESET('HEIGHT')
C
C<><><><><><><><><><><><><><><><>C
C  INITIALIZE THE PLOTTING LOOP  C
C<><><><><><><><><><><><><><><><>C
      J=0
      NFLAG=0
      U(1)=HU*DX
      L(1)=HL*DX
C
C<><><><><><><><><><><><><><><><>C
C  ENTER MAIN LOOP               C
C<><><><><><><><><><><><><><><><>C
  1   J=J+1
      IF(J.EQ.JMAX) GO TO 5
      READ(KCI,6) HX,HU,HL
      X(2)=HX
      IF(HX.LT.XMAX) GO TO 4
C
  5   X(2)=XMAX
      NFLAG=1
C
  4   U(2)=U(1)
      L(2)=L(1)
      IF(U(1).LE.0.0) GO TO 2
      X(3)=X(2)
      U(3)=HU*DX
      L(3)=HL*DX
      IF(U(3).GT.0) GO TO 7
      U(3)=U(2)
      L(3)=L(2)
C
C<><><><><><><><><><><><><><><><>C
C  DRAW CONFIDENCE LIMITS        C
C<><><><><><><><><><><><><><><><>C
  7   CALL CURVE(X,U,3,0)
      CALL CURVE(X,L,3,0)
C
  2   IF(NFLAG.EQ.1) RETURN
C
      X(1)=X(2)
      U(1)=HU*DX
      L(1)=HL*DX
      GO TO 1
C
  3   FORMAT(I5)
  6   FORMAT(3A6)
      END
EOF:88 SCAN:62
```

DECADE

```
      SUBROUTINE DECADE(XMN,XMX)
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C       SUBROUTINE DECADE ROUNDS XMN DOWN TO THE NEXT LOWEST  C
C       POWER OF 10 AND ROUNDS XMX UP TO THE NEXT HIGHEST     C
C       POWER OF 10.                                          C
C                                                             C
C          ON ENTRY  XMN AND XMX ARE ASSUMED TO BE REAL       C
C                    NUMBERS GREATER THAN 10◆◆(-6).           C
C                                                             C
C          ON EXIT   XMN AND XMX ARE THE ROUNDED VALUES.      C
C                                                             C
C          NOTE      IF XMN OR XMX WERE INPUT LESS THAN       C
C                    OR EQUAL TO 10◆◆(-6), THEN THE OUTPUTS   C
C                    ARE 10◆◆(-6) AND 10◆◆(-5) RESPECTIVELY.  C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C                               (see figure E-6 on next page for flow chart)
      D=.000001
      C=D
C
    1 C=10.◆C
      IF(XMN.GE.C) GO TO 1
      XMN=C/10.
C
    2 D=10.◆D
      IF(XMX.GT.D) GO TO 2
      XMX=D
C
      RETURN
      END
EOF:29
0:>
```

DECADE (CONT'D.)

Subroutine DECADE Flow Chart

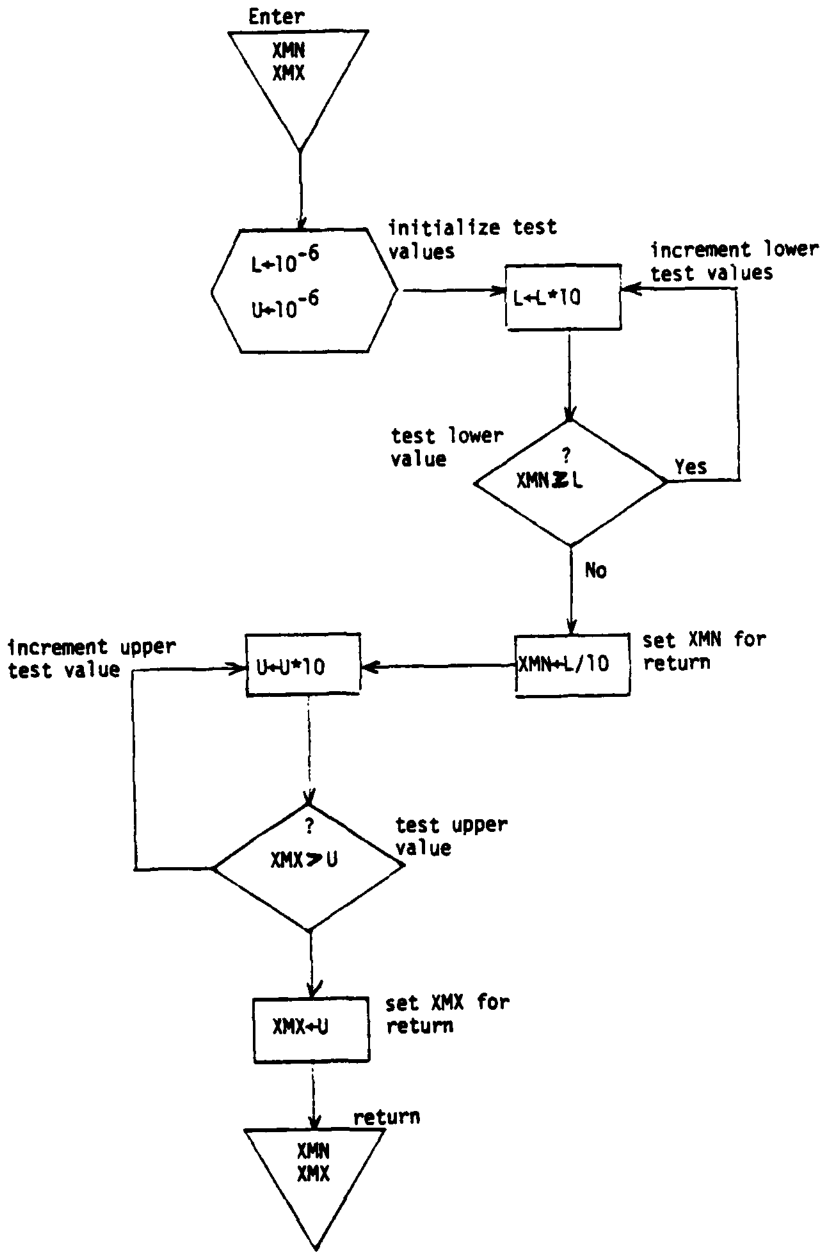


Figure E-6

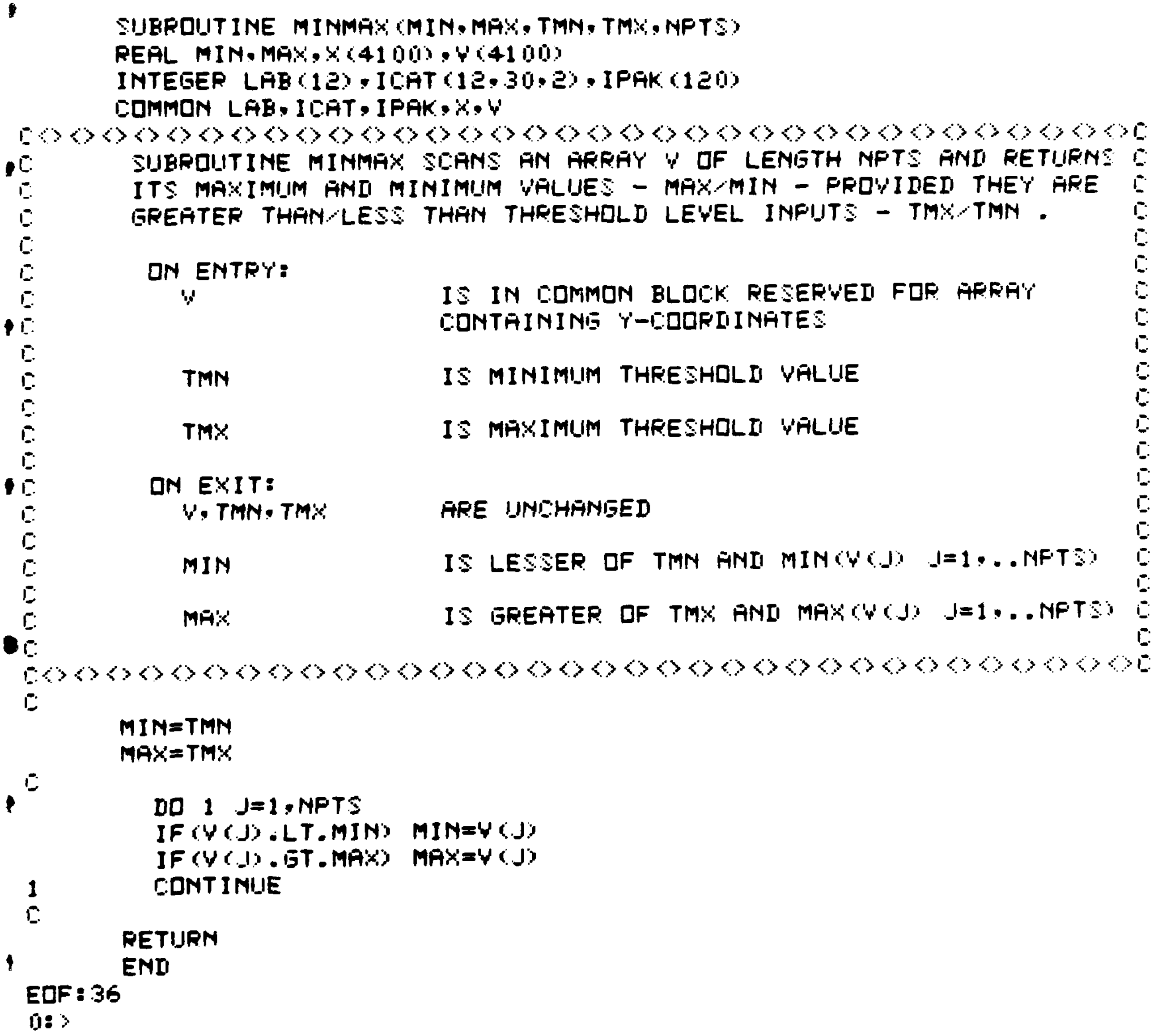
DOWN

```
      SUBROUTINE DOWN(NBOT,YPOS,Q)
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C      SUBROUTINE DOWN FURNISHES AN EFFECTIVE 'INVERSE' FOR            C
C      SUBROUTINE UP, I.E., IT MOVES THE PHYSICAL  ORIGIN DOWN        C
C      AND INCREASES  THE LENGTH OF THE Y-AXIS.                       C
C                                                                      C
C       ON ENTRY:                                                      C
C                                                                      C
C         NBOT            ESCAPE PARAMETER                             C
C                          NBOT=0    RETURN WITHOUT EXECUTION          C
C                          NBOT=1    ROUTINE EXECUTED                  C
C                                                                      C
C         YPOS            LENGTH IN INCHES FROM BOTTOM OF PAGE         C
C                         TO PHYSICAL ORIGIN                           C
C                                                                      C
C       ON EXIT:                                                       C
C                                                                      C
C         NBOT            ENTRY VALUE MINUS 1.5                        C
C                                                                      C
C         YPOS            ENTRY VALUE PLUS 1.5                         C
C                                                                      C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
      IF(NBOT.NE.0) RETURN
      YPOS=YPOS-1.5
      Q=Q+1.5
      RETURN
      END
EOF:27
0:>
```

LABEL

```
      SUBROUTINE LABEL(NCAT,ITEM)
      INTEGER ICAT(12,30,2),LAB(12)
      COMMON LAB,ICAT
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C      SUBROUTINE LABEL SELECTS A LABEL FROM AMONG THOSE STORED IN     C
C      THE TRIPLY SUBSCRIPTED 'CATALOG' ARRAY ICAT AND PLACES IT IN    C
C      THE SINGLY SUBSCRIPTED 'TRANSFER' ARRAY LAB. CALLS TO LABEL     C
C      ARE USUALLY MADE AS PREPARATION FOR A CALL TO ONE OF THE        C
C      DISSPLA TITLING OR MESSAGE ROUTINES.                            C
C                                                                      C
C       ON ENTRY:                                                      C
C                                                                      C
C         NCAT           IS CATALOG SELECTION PARAMETER                C
C                         1 - DEFAULT CATALOG                          C
C                         2 - CATALOG OF USER SUPPLIED LABELS          C
C                                                                      C
C         ITEM           IS THE CATALOG NUMBER OF THE LABEL            C
C                        SELECTED                                      C
C                                                                      C
C       ON EXIT:         LAB(I)=ICAT(I,ITEM,NCAT)   I=1,.....,12       C
C                                                                      C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C
        DO 2 J=1,12
        LAB(J)=ICAT(J,ITEM,NCAT)
  2     CONTINUE
      RETURN
      END
EOF:28
0:>
```

MINMAX



```
      SUBROUTINE MINMAX(MIN,MAX,TMN,TMX,NPTS)
      REAL MIN,MAX,X(4100),V(4100)
      INTEGER LAB(12),ICAT(12,30,2),IPAK(120)
      COMMON LAB,ICAT,IPAK,X,V
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C       SUBROUTINE MINMAX SCANS AN ARRAY V OF LENGTH NPTS AND RETURNS C
C       ITS MAXIMUM AND MINIMUM VALUES - MAX/MIN - PROVIDED THEY ARE  C
C       GREATER THAN/LESS THAN THRESHOLD LEVEL INPUTS - TMX/TMN .     C
C                                                                     C
C        ON ENTRY:                                                    C
C          V                   IS IN COMMON BLOCK RESERVED FOR ARRAY  C
C                              CONTAINING Y-COORDINATES               C
C                                                                     C
C          TMN                 IS MINIMUM THRESHOLD VALUE             C
C                                                                     C
C          TMX                 IS MAXIMUM THRESHOLD VALUE             C
C                                                                     C
C        ON EXIT:                                                     C
C          V,TMN,TMX           ARE UNCHANGED                          C
C                                                                     C
C          MIN                 IS LESSER OF TMN AND MIN(V(J)  J=1,..NPTS)  C
C                                                                     C
C          MAX                 IS GREATER OF TMX AND MAX(V(J)  J=1,..NPTS) C
C                                                                     C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C
      MIN=TMN
      MAX=TMX
C
        DO 1  J=1,NPTS
        IF(V(J).LT.MIN)  MIN=V(J)
        IF(V(J).GT.MAX)  MAX=V(J)
1       CONTINUE
C
      RETURN
      END
EOF:36
0:>
```

MNPL

```
      SUBROUTINE MNPL(NOPT,XMN,XMX,YMN,YMX,YSTP,NPTS,P,QQ)
      INTEGER LAB(12),ICAT(12,30,2),IPAK(120)
      REAL XMN,XMX,YMN,YMX,YSTP,X(4100),Y(4100),QQ
      COMMON LAB,ICAT,IPAK,X,Y
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C      SUBROUTINE MNPL CALLS THE DISSPLA ROUTINES WHICH ARE     C
C      APPROPRIATE FOR SETTING UP THE GRAPH AXES AS SPECIFIED   C
C      BY THE USER.                                             C
C                                                               C
C      ON ENTRY:                                                C
C       NOPT   .    AXIS SELECTION PARAMETER                    C
C                    NOPT     X-AXIS     Y-AXIS                 C
C                     0        LOG        LIN                   C
C                     1        LIN        LIN                   C
C                     2        LOG        LOG                   C
C                                                               C
C       XMN,XMX     ARE THE MINIMUM AND MAXIMUM VALUES WHICH    C
C                   APPEAR ON THE X-AXIS.                       C
C                                                               C
C       YMN,YMX     ARE THE MINIMUM AND MAXIMUM VALUES WHICH    C
C                   APPEAR ON THE Y-AXIS.                       C
C                                                               C
C       YSTP        THE DISTANCE IN AXIS UNITS BETWEEN          C
C                   Y-AXIS TICK MARKS.                          C
C                                                               C
C       P,QQ        LENGTHS OF X AND Y AXES IN INCHES.          C
C                                                               C
C       X,Y         ARRAYS WHICH HOLD X AND Y COORDINATES OF    C
C                   POINTS TO BE PLOTTED.                       C
C                                                               C
C       LAB         ARRAY WHICH HOLDS THE Y-AXIS LABEL.         C
C                                                               C
C       NPTS        NUMBER OF POINTS TO BE PLOTTED.             C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C                                  (see figure E-7 on next page for flow chart)
      IF(NOPT.EQ.1) GO TO 5
C
      CALL ALGPLT(XMN,XMX,P,XOR,XCYCLE)
      CALL XLOG(XOR,XCYCLE,0.,1.)
C
      IF(NOPT.EQ.2) GO TO 15
      GO TO 10
C
  5   CALL GRAF(XMN,'SCALE',XMX,YMN,YSTP,YMX)
C
  10  CALL YGRAXS(YMN,YSTP,YMX,QQ,LAB,100,0.,0.)
      GO TO 20
C
  15  CALL ALGPLT(YMN,YMX,QQ,YOR,YCYCLE)
      CALL YLGAXS(YOR,YCYCLE,QQ,LAB,100,0.,0.)
C
  20  CALL CURVE(X,Y,NPTS,0)
      D=1
      RETURN
      END
EOF:55
0:>
```

Subroutine MNPL Flow Chart

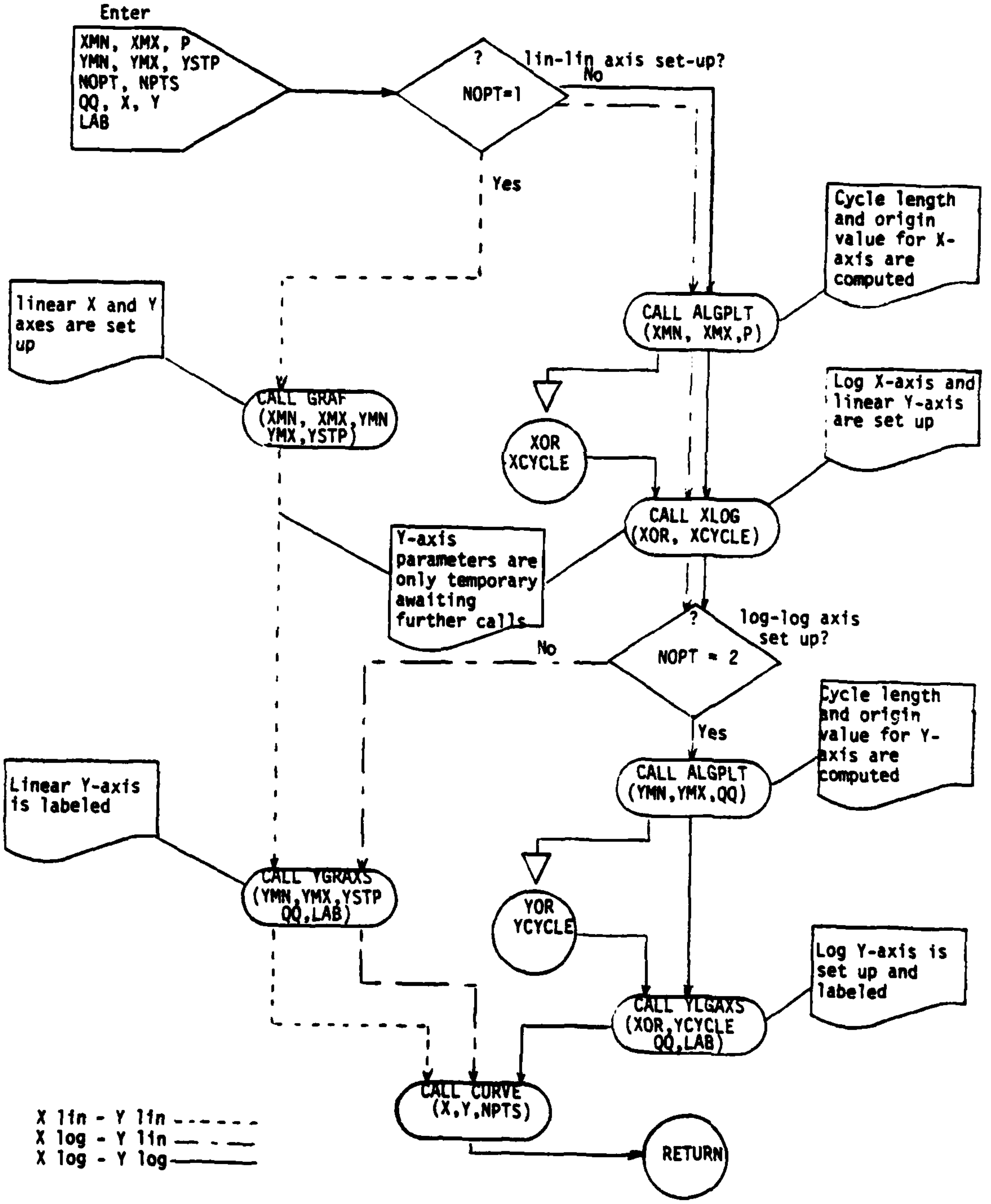

Enter
XMN, XMX, P
YMN, YMX, YSTP
NOPT, NPTS
QQ, X, Y
LAB
?
NOPT=1
lin-lin axis set-up?
No
Yes
Cycle length and origin value for X-axis are computed
CALL ALGPLT (XMN, XMX,P)
linear X and Y axes are set up
CALL GRAF (XMN, XMX,YMN YMX,YSTP)
XOR XCYCLE
Log X-axis and linear Y-axis are set up
CALL XLOG (XOR, XCYCLE)
Y-axis parameters are only temporary awaiting further calls
?
NOPT = 2
log-log axis set up?
No
Yes
Cycle length and origin value for Y-axis are computed
CALL ALGPLT (YMN,YMX,QQ)
Linear Y-axis is labeled
CALL YGRAXS (YMN,YMX,YSTP QQ,LAB)
YOR YCYCLE
Log Y-axis is set up and labeled
CALL YLGAXS (XOR,YCYCLE QQ,LAB)
CALL CURVE (X,Y,NPTS)
RETURN
X lin - Y lin
X log - Y lin
X log - Y log

Figure E-7

SETMES

```
      SUBROUTINE SETMES(ITEM,XP,YP)
      INTEGER LAB(12),ICAT(12,30,2)
      COMMON LAB,ICAT
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><C
C      SUBROUTINE SETMES TAKES A SELECTED LABEL FROM THE DEFAULT  C
C      CATALOG CONTAINED IN ARRAY ICAT AND WRITES IT AT A SPEC-   C
C      IFIED LOCATION ON THE PLOT.                                C
C                                                                 C
C      ON ENTRY:                                                  C
C        ITEM    IS THE CATALOG NUMBER OF THE SELECTED LABEL      C
C                                                                 C
C        XP,YP   ARE THE HORIZONTAL AND VERTICAL DISTANCES IN     C
C                INCHES FROM THE CURRENT PLOT ORIGIN TO THE       C
C                LOCATION WHERE THE MESSAGE STARTS.               C
C                                                                 C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><C
      CALL HEIGHT(.1)
      CALL LABEL(1,ITEM)
      CALL MESSAG(LAB,100,XP,YP)
      CALL RESET('HEIGHT')
      RETURN
      END
EOF:22
0:>
```

SETUP

```
      SUBROUTINE SETUP(K,KU,NCAT,NBOT,NOPT,NPTS,IT)
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
C      SUBROUTINE SETUP READS USER INSTRUCTION DATA AND USES IT TO     C
C      SET THE PROGRAM CONTROL PARAMETERS NECESSARY FOR CARRYING       C
C      OUT THE ENCODED INSTRUCTIONS.                                   C
C                                                                      C
C      ON ENTRY:                                                       C
C                                                                      C
C        K                     IS PARAMETER FOR SELECTING AXIS TYPE    C
C                              AND LABEL CATALOG                       C
C         =0         =>           NO PLOT WANTED - RETURN              C
C         >0         =>           TITLES AND LABELS SELECTED FROM      C
C                                 DEFAULT CATALOG                      C
C         <0         =>           TITLES AND LABELS SELECTED FROM      C
C                                 USER SUPPLIED CATALOG                C
C        ABS(K)=1    =>           X-LOG   Y-LIN                        C
C              =2    =>           X-LIN   Y-LIN                        C
C              =3    =>           X-LOG   Y-LOG                        C
C                                                                      C
C        KU                    FORTRAN UNIT NUMBER FOR THE DATA SET    C
C                              CONTAINING USER CONTROL RECORDS         C
C                                                                      C
C      ON EXIT:                                                        C
C                                                                      C
C        NCAT                  IS CATALOG SELECTION PARAMETER          C
C            =1      =>           DEFAULT CATALOG      (K>0)           C
C            =2      =>           USER SUPPLIED CATALOG  (K<0)         C
C                                                                      C
C        NBOT                                                          C
C            =0      =>           CURRENT METER DATA NOT WANTED        C
C            =1      =>           CURRENT METER DATA TO BE WRITTEN AT  C
C                                 BOTTOM OF PLOT                       C
C                                                                      C
C        NOPT                  AXIS SELECTION PARAMETER                C
C            =0      =>           X-LOG   Y-LIN                        C
C            =1      =>           X-LIN   Y-LIN                        C
C            =2      =>           X-LOG   Y-LOG                        C
C                                                                      C
C        NPTS                  NUMBER OF POINTS TO BE PLOTTED          C
C                                                                      C
C        IT(J)                 ARRAY CONTAINING CATALOG NUMBERS FOR    C
C                              TITLES AND LABELS                       C
C         J=1,2,3    =>           IT(J) CONTAINS CATALOG NUMBER FOR    C
C                                 LINES OF TITLE                       C
C          =4        =>           IT(J) CONTAINS CATALOG NUMBER FOR    C
C                                 X-AXIS LABEL                         C
C          =5,6,7    =>           IT(J) CONTAINS CATALOG NUMBER FOR    C
C                                 Y-AXIS LABELS                        C
C                                                                      C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><>C
50:>
```

```
      INTEGER IT(13),LT(13)
      READ(KU,99) NBOT,MPTS,(LT(J),J=1,13)
      IF(MPTS.NE.0.AND.MPTS.LE.NPTS) NPTS=MPTS
      NCAT=1
      IF(K.GT.0) GO TO 1
C
        DO 2 L=1,13
        IT(L)=LT(L)
2       CONTINUE
      NCAT=2
      K=-K
C
1     NOPT=K-1
99    FORMAT(15I5)
      RETURN
      END
EOF:66 SCAN:15
0:>
```

TOP

```
      SUBROUTINE TOP(NCAT,IT)
      INTEGER IT(20),LAB(12),ICAT(12,30,2)
      COMMON LAB,ICAT
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><C
C      SUBROUTINE 'TOP' MAKES USE OF DISSPLA ROUTINE 'HEADIN'     C
C      TO PLACE A TITLE ON THE PLOT.                              C
C                                                                 C
C      THE LINES IN THE TITLE ARE SELECTED ONE AT A TIME FROM     C
C      THE CATALOG OF LABELS CONTAINED IN ARRAY ICAT AND          C
C      STORED IN ARRAY LAB FOR INPUT TO 'HEADIN'.                 C
C                                                                 C
C      ON ENTRY:                                                  C
C        NCAT    CATALOG SELECTION PARAMETER                      C
C                1 - DEFAULT CATALOG                              C
C                2 - USER SUPPLIED LABELS                         C
C                                                                 C
C        IT      ARRAY CONTAINING THE CATALOG NUMBERS FOR         C
C                THE SELECTED LINES.                              C
C                IT(J)= CATALOG NUMBER FOR J-TH LINE OF TITLE     C
C                       (J=1,2,3.)                                C
C                IT(J)=0 SIGNALS THAT THERE ARE ONLY J-1 LINES    C
C                       IN THE TITLE.                             C
C                                                                 C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><C
C
C<><><><><><><><><><><><><><><><><><><>C
C  DETERMINE NUMBER OF LINES IN TITLE  C
C<><><><><><><><><><><><><><><><><><><>C
      IF(IT(1).EQ.0) RETURN
      NLINES=1
        DO 2 L=2,3
        IF(IT(L).EQ.0) GO TO 3
        NLINES=NLINES+1
  2     CONTINUE
C
C<><><><><><><><><><><><><><><><><><><>C
C  WRITE THE LINES OF TITLE            C
C<><><><><><><><><><><><><><><><><><><>C
 3      DO 4 J=1,NLINES
        ITEM=IT(J)
        CALL LABEL(NCAT,ITEM)
        NHGT=3
        CALL HEADIN(LAB,100,NHGT,NLINES)
  4     CONTINUE
C
      RETURN
      END
EOF:47
0:>
```

UP

```
      SUBROUTINE UP(NBOT,YPOS,Q)
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><C
C      SUBROUTINE UP IS USED TO MAKE ROOM AT THE BOTTOM OF THE          C
C      PLOT FOR WRITING CURRENT METER INFORMATION. THIS IS DONE BY     C
C      MOVING THE PHYSICAL ORIGIN UP AND REDUCING THE VERTICAL         C
C      AXIS LENGTH.                                                    C
C                                                                      C
C       ON ENTRY:                                                      C
C                                                                      C
C         NBOT               ESCAPE PARAMETER                          C
C                             NBOT=0    RETURN WITHOUT EXECUTION       C
C                             NBOT=1    ROUTINE IS EXECUTED            C
C                                                                      C
C         YPOS               LENGTH IN INCHES FROM BOTTOM OF PAGE      C
C                            TO PHYSICAL ORIGIN                        C
C                                                                      C
C         Q                  LENGTH IN INCHES OF Y-AXIS                C
C                                                                      C
C       ON EXIT:                                                       C
C                                                                      C
C         NBOT               ENTRY VALUE PLUS 1.5                      C
C                                                                      C
C         YPOS               ENTRY VALUE MINUS 1.5                     C
C                                                                      C
C<><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><><C
      IF(NBOT.NE.0) RETURN
      YPOS=YPOS+1.5
      Q=Q-1.5
      RETURN
      END
EOF:30
0:>
```

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REFERENCES

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JAYCOR

27 February 1980

Dr. E. Michael Stanley
Naval Ocean Research and Development Activity
Environmental Measurements Program (Code 500)
NSTL Station, Mississippi 39529

Dear Dr. Stanley:

Enclosed is the final version of the "User's Manual for Computer Programs to Perform Oceanographic Vector Times Series Data Analysis and Related Graphics," which represents a deliverable under contract N00014-78-C-0879. The document is divided into two parts: the introductory material and instructions to users, and the program source listing and test data sets.

This software represents the state-of-the-art in vector time series analysis, and will be both durable and versatile, being able to accommodate a number of types of time series of oceanographic or meteorologic vectors. Due to the complex nature of vector time series analysis, it is strongly recommended that any user read the manual very carefully, beginning with the preface, before trying to use the software. We have found in the testing phase that many problems that were encountered were the result of casual reading of the manual and not in the software itself. Also, in this way, the user can take full advantage of the wide range of options available in both the analysis portion of the programs as well as in the graphics.

We regret the delay in submitting this final document, but acknowledge, as you do, the multitude of difficulties that were overcome to reach this point.

We sould like to recognize the valuable assistance provided us by Dr. Kim Saunders and Mr. Mark Bergin. Without their aid in working with the NAVOCEAN computer system, this task would have been extremely difficult to complete. We have enjoyed working with the NORDA staff on this project and look forward to future projects for you and the environmental measurements program.

Sincerely yours,

Francis C. Monastero

Francis C. Monastero
Director
Ocean and Environmental Sciences Division

Distribution of Final Report Under Contract No. N00014-78-C-0879

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